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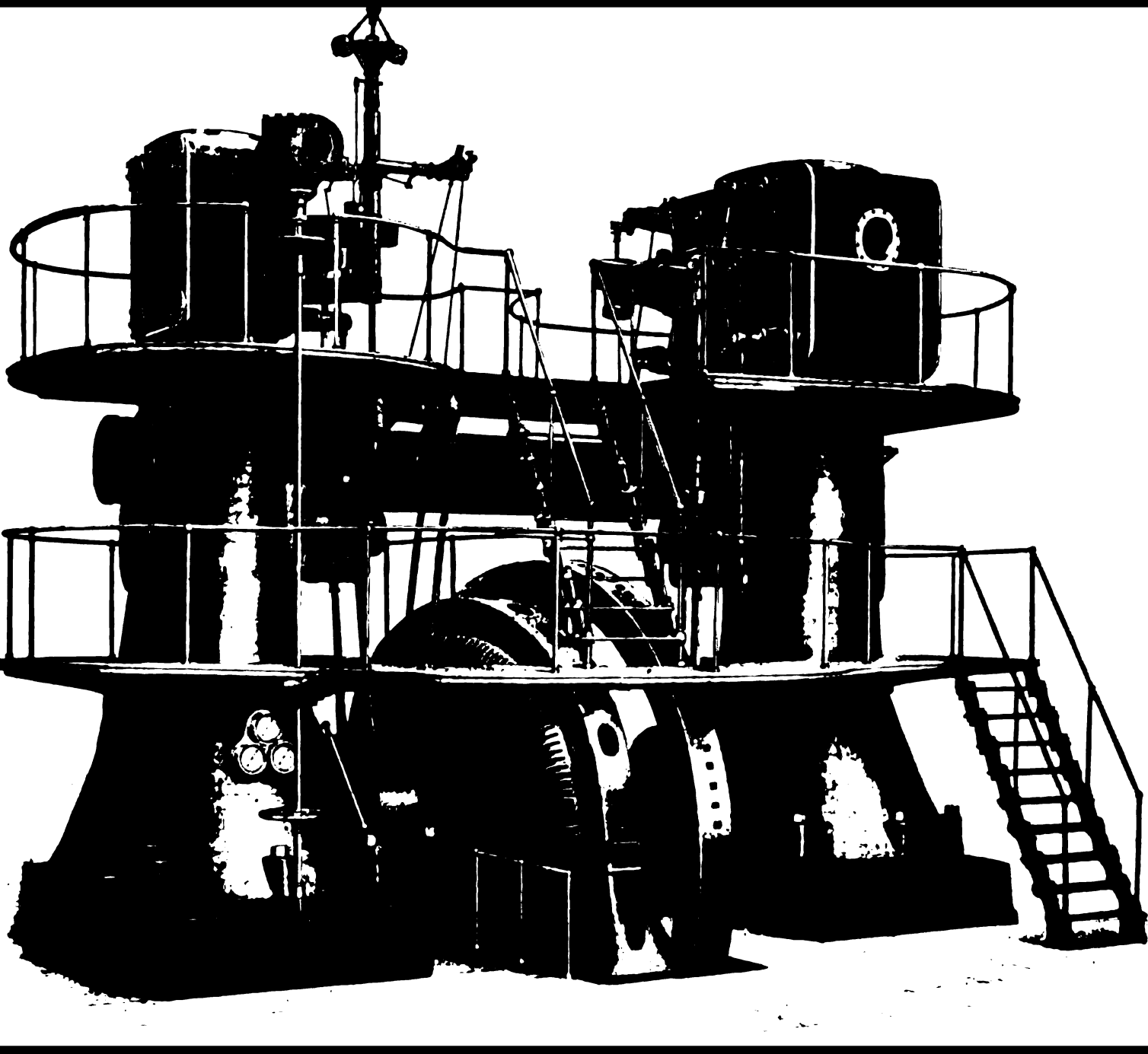

Central Station

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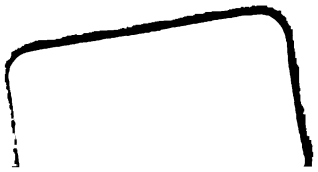

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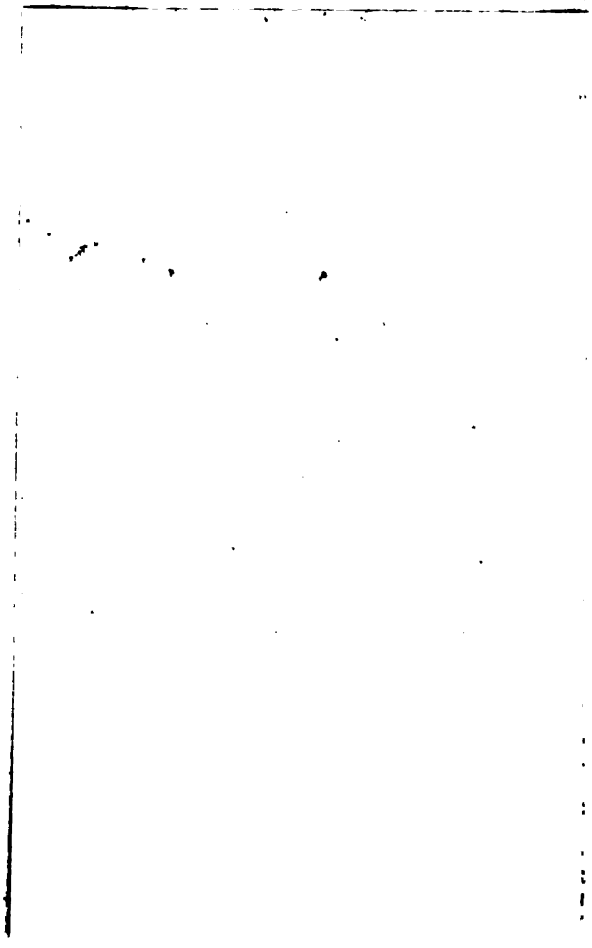

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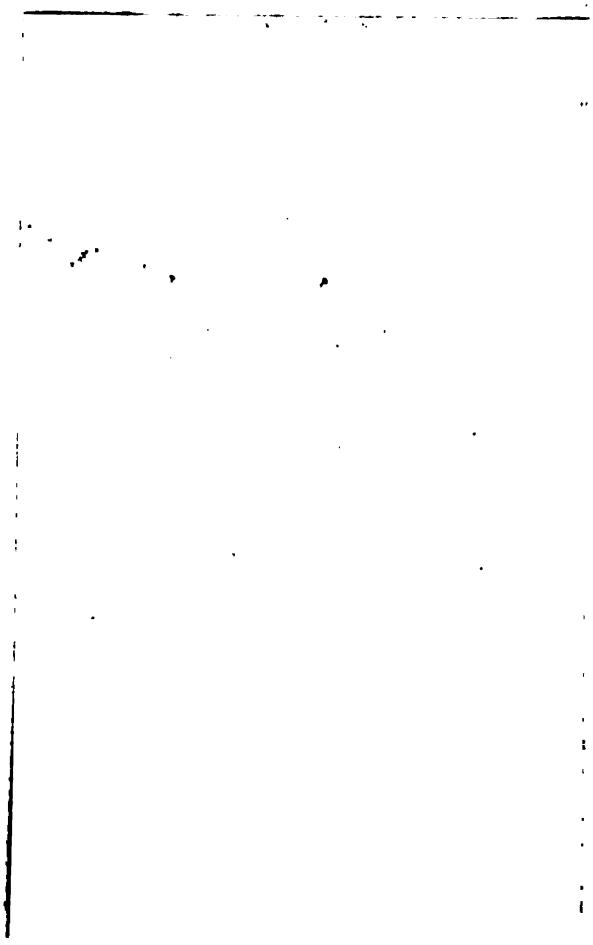

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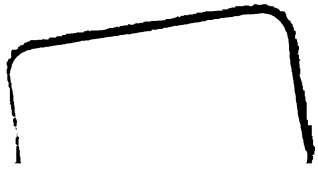

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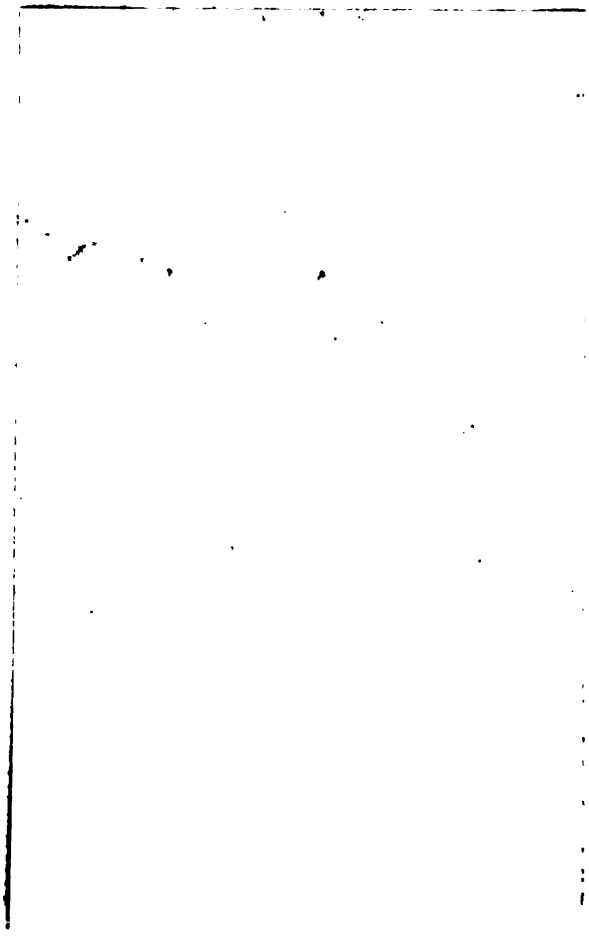

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National Electric Light Association Convention, Report Number

The Central Station

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS

Vol. 7. No. 1. JULY, 1907. One Dollar a Year.

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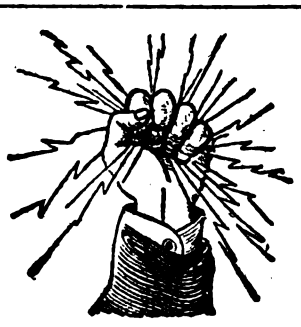

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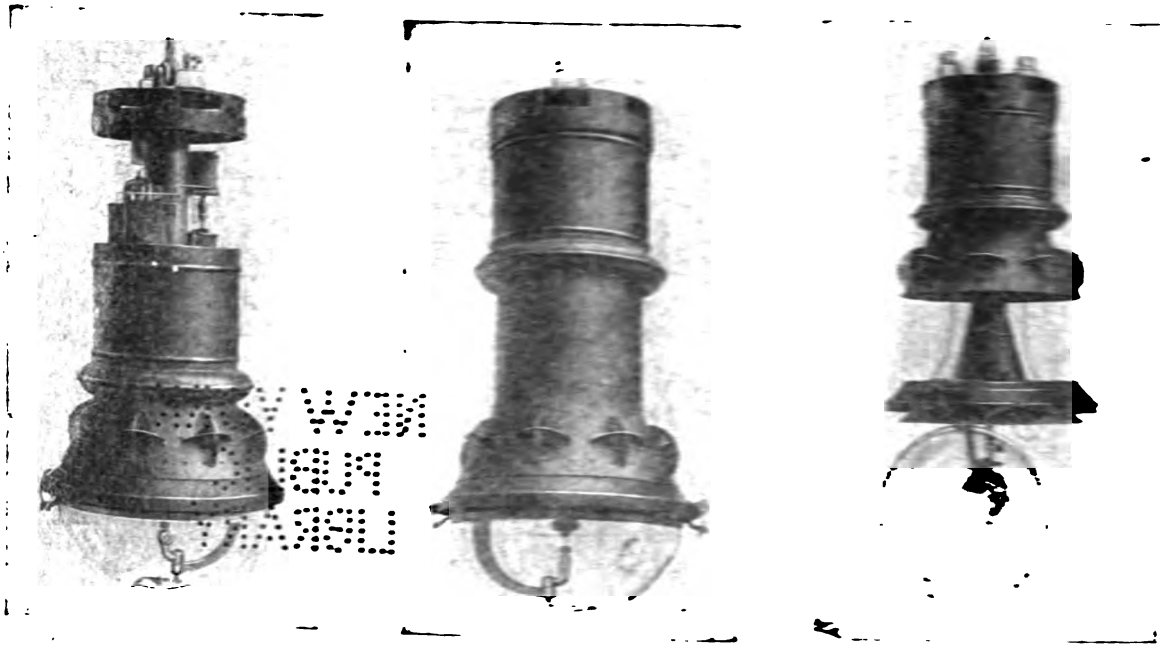

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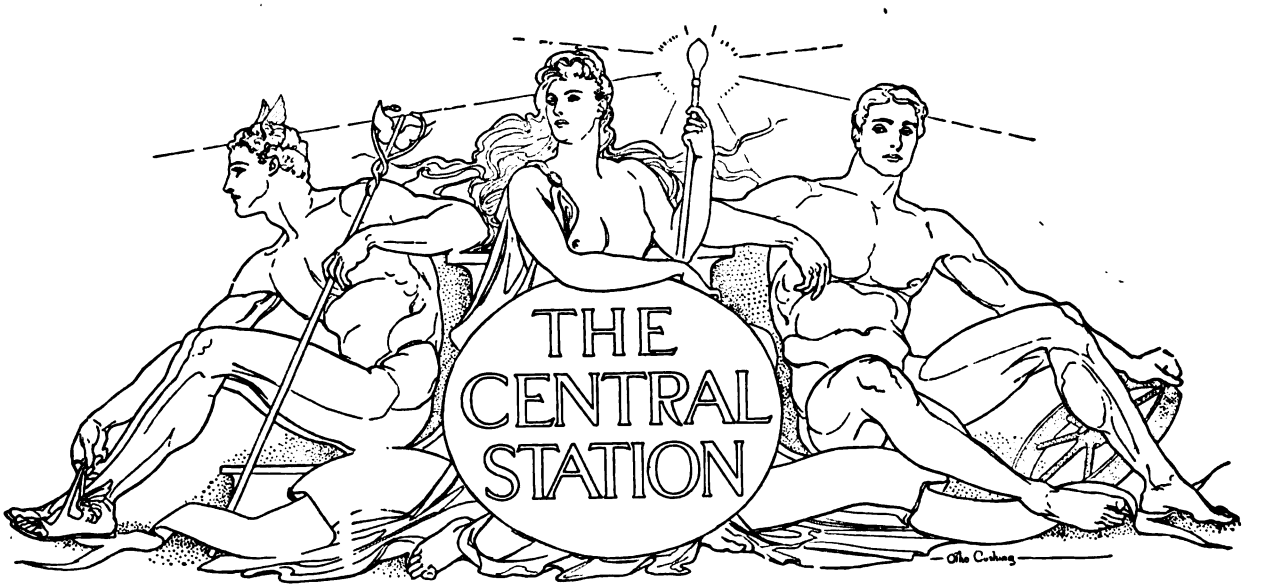

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VOL. 7, NO. 1. NEW YORK, JULY, 1907 ISSUED MONTHLY

THE NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION.

NEW YORK
PUBLIC

Sixteen hundred and seventy-five delegates were officially registered at the 30th convention of the National Electric Light Association, held in the New Willard Hotel in Washington, D. C., June 4th to 7th.

This is the record number since the Association was formed in 1885, and exceeds in number that of the next largest convention, which was the 29th, held at Atlantic City, N. J., June 5th to 8th, 1906, at which 1,461 delegates were registered.

The National Electric Light Association now has an aggregate membership, including all classes, of 1,286.

This Association represents the interests of the electric lighting and power stations, of which there are to-day five thousand, representing a capital invested of over $850,000,000, with a yearly revenue of $170,000,000.

Nearly every train from the north, south and west brought delegates from every State, and at the opening of the Electrical Exhibition, on Monday evening, June 3rd, which took place on the tenth floor of the New Willard Hotel, which was the headquarters of the convention, over one thousand delegates were present. The tenth floor of the New Willard Hotel is divided into two ante-rooms and one enormous ball room. The latter was divided up for the use of the exhibitors in equal spaces, separated by uniform railings painted with white and gold enamel. The entire ceiling of the Exhibition Hall was decorated by three thousand feet of Elb light cable, and 3,500 orange-colored Elblight lamps intertwined with smilax, which furnished the most beautiful and artistic electrical decoration ever seen in this country. The meeting room, where the business of the convention was carried on and where the various papers were read and discussed, had a seating capacity of four hundred.

The transportation and registration offices occupied the ante-room at the other end of the Exhibition Hall, and marked one of the many carefully thought out details of the president of the Association, Mr. Arthur Williams.

Every member of the Association was asked, in advance of the convention, to send in his registration, and upon his arrival in Washington, the Regis-

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tration Department handed him an envelope which contained the badge of his membership class, at the top of which was a little panel with his name printed thereon. This was a decided improvement over the old method of numbered buttons, and at once did away with the embarrassment occasioned at former conventions in not remembering the names of the familiar faces which, to many of us, are seen only once a year on these occasions.

The first session of the convention was called to order at 10.15 A. M., Tuesday, June 4, with President Arthur Williams in the chair.

President Williams apologized for calling the Association to order a quarter of an hour after the appointed time, but assured those present that all future sessions would commence promptly as scheduled. He then introduced General George H. Harries, Vice-President of the Washington Railway and Electric Company, who spoke briefly upon the form of government of the District of Columbia, which he held up as an example to other cities. The municipal administration is thoroughly clean, said General Harries, and every dollar appropriated goes directly to the one item for which that dollar is intended, there being no "rake-off." Mr. H. B. MacFarland, President of the Board of Commissioners of the District of Columbia, then delivered his address of welcome. Mr. MacFarland's speech was bright and, like all clever speeches, was brief. He concluded by assuring us all that we were free citizens of the National Capital by right of birth.

President Williams then delivered his most interesting address which follows:

President Williams' Address.

It gives me pleasure to welcome the delegates and those with them to our thirtieth convention. This is the second meeting of the Association in this beautiful city. The former was held here early in 1894, slightly more than 13 years ago.

Then the active, Class A, membership included 107 companies; now it includes 709 companies; then there were 112 associate, Class D, members; now there are 151; then we had 27 honorary members, now 31. In these three classes there were then 246 members; now there are 884 members.

Since that convention two membership classes have been added—the B now including 317 members and the E, including 85 members—a total of 402 members, making at present an aggregate in all classes of 1,286 members.

In addressing that convention President Armstrong stated there were "upward of 2,300 central stations in this country, representing at least $200,000,000 of capital." According to our honorary member, Mr. T. C. Martin, in his United States Census Report on the North American Continent, there are now more than 5,000 central stations; the investment in the United States alone has reached $850,000,000; the gross annual revenue $165,000,000; the gross return yearly thus approximating the investment of the industry in 1894.

Then the dominating thought was technical, mechanical and electrical. The American in whatever he does moves rapidly. In operating limitations, development toward the practical, if not the ideal, has about been reached, and now the predominating thought in a convention such as this, while giving due regard to engineering problems, tends more especially to the commercial development and to broad questions of management which, in the highest sense, affect our relations with the general public.

Notwithstanding this change the technique of our industry has not been neglected in the programme of this convention. Much that is new in protective devices will be presented; we shall hear of recent developments in the steam turbine; the gas engine will receive the attention it appears increasingly to deserve, and in connection with the report of the committee on street-lighting specifications we may expect to hear of the latest developments in incandescent and arc lamps and in other forms of artificial illumination. Upon these and other technical matters we shall hear from some of the country's highest authorities.

Examples of the new tungsten lamp consuming slightly more than one watt per candle will be on exhibition; metallized filaments may now be obtained in quantities with an efficiency of 2½ watts, and we are given to understand that this lamp will soon be available with an efficiency of two watts per candle. In this room will be shown mercury, magnetite and other luminous arc lamps, and we hope the meeting will result in much available information concerning their illuminating power, adaptability and practical usefulness in commercial service.

These higher efficiencies in incandescent lamps will introduce new problems in the management of central stations. Thus far the consumption of the lamp as a unit has been changed but little, the improvement being an increased illuminating power.

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More light may thus be obtained by the consumer without increase in the cost or material reduction in the load on the station.

The increase in the use of incandescent lamps during the last five years may be of interest. In 1900 the number used was 21,191,131; in 1905, 88,333,285 lamps of 16 candles.

MR. DUDLEY FARRAND, PRESIDENT NATIONAL ELECTRIC LIGHT ASSOCIATION.

During the year the Association's committees have rendered splendid service. To attend meetings some of the members have traveled great distances. Their reports should be received with close attention. Perhaps passed over, sometimes without much apparent notice, undoubtedly the reports of our committees have done much to mold the opinions and methods of our membership.

Though not the time to consider in detail our committee work, I cannot but refer to the success attending the efforts of a sub-committee of the public policy committee, consisting of Messrs. Charles L. Edgar, Chairman, Samuel Insull and J. W. Lieb, Jr., in securing a satisfactory adjustment of the differences between member companies at Lockport, N. Y.; nor should I fail to refer to the manner—thoroughly public-spirited and in the interest of our industry—in which the executives of these companies and their respective boards of directors have coöperated in every practicable way in making possible the satisfactory solution that has been reached.

The public policy committee has accomplished another notable feature in securing closer relationship for suggesting proper ways of maintaining more cordial relations with the public between the other public-service interests and our own. Representatives of the several associations met at the invitation of the chairman, Mr. Everett W. Burdett, and, at the suggestion of that gathering, each of the represented associations has appointed, or will appoint, two members to form a joint working committee for the purpose of securing closer intercourse and more frequent exchange of views. So important has been the work of this committee that an entire evening has been assigned to the reception and consideration of its report.

Questions have arisen recently concerning the rating of the so-called 2,000-candle-power municipal arc lamps. Those of our members who have occasion to refer to this matter would do well to consult the "Report of the Special Committee on the Rating of Arc Lamps," appearing in the Proceedings of the 1894 convention, which will be referred to more fully in the report of the committee on street-lighting specifications. Recent improvements in arc lamps and the possibility of their adoption for

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street illumination has made it seem desirable to consider the practicability of returning in some form to a candle-power rating. It was for this purpose that the committee was appointed, of which our first vice-president, Mr. Dudley Farrand, is chairman. Several meetings were held during the year, each attended by every member, and the report should be awaited with a great deal of interest.

Corporation accounting is receiving widespread attention. That which is desirable for one company would seem so for another—allowing for local differences. Your committee on this subject, of which Mr. H. M. Edwards is chairman, consists of eminent accountants; its report is most complete and the efforts of our Association should be toward its general adoption, at least basicly, throughout the accounting methods of our industry.

A report will be submitted by the committee on dues, of which Mr. W. H. Gardiner is chairman, looking to an increase in the revenue of the Association. With the occupancy of the larger offices go increased expenses, and the work of the Association as a whole is so broadening out that increased expenditure will be required. The object of the committee has been to provide additional revenue, placing the increase fairly upon those who are best able to bear it.

It seems fitting to mention that but a portion of our expenditures is made through the Association's treasury. The contributions of some member companies—direct and indirect—amount to large sums each year. Take as an illustration the member who travels hundreds of miles and gives several days of his time; as another, the subscriptions toward our convention expenses. In many other ways these expenditures may be large, but not the slightest complaint has been made, and each member seems to feel that more than an equivalent is returned through its connection with the Association.

The committee on constitution and by-laws, of which Mr. Samuel Scovil is chairman, will make a report at one of the executive sessions. This report, while containing few if any radical changes, makes the constitution and by-laws more convenient and clear upon some points concerning which in the past doubt may have arisen.

Coöperation promises to be one of the keynotes of the century's progress. As elsewhere, it extends into the field of advertising. The committee appointed to consider the subject, of which Mr. W. W. Freeman is chairman, has worked in conjunction with the Coöperative Electrical Development Association, and a report of its conclusions will be made at a later session.

In the movement toward the municipal socialism, which for a time threatened to sweep the country, there seems to have been a pause. As opposed to it Chicago and London have won notable victories during the year. This appears to have been done entirely through an educational appeal to public reason. The facts for and against the movement have been fully and clearly stated and the public was not slow in deciding between right and wrong, nor long in making known its decision.

Fair play may be expected from the American public. But it must have facts, not personal opinions with nothing behind them other than "mere assertion." For many years the public has heard only one side of the question and therefore could not do otherwise than form a one-sided—and as subsequent events have proved—a wrong opinion. This pause should not be considered as a victory. Rather, simply an indication that the public is willing to hear both sides and to render its opinion in favor of those who, in their treatment of the public, are in turn entitled to public support.

The power of public opinion and the resistless force it exerts when centered upon a given subject has been one of the object lessons of the year. It promises to become increasingly a predominant feature in the conduct of the affairs—political, corporate and individual—of our American municipalities. It should be carefully studied, shaped where wrong and always reckoned with.

Our own is one of the industries through which public opinion may be greatly affected. The men who are in attendance at this convention are in a position personally, and through their subordinates, to make an impression for good or for ill upon a large percentage of our 80,000,000 of population Whether our rates are fair and made without discrimination; whether our representatives are competent and courteous; whether our service is of high standard, all are elements which go to make public opinion favorable or unfavorable, and in this there is no detail too small or seemingly too unimportant to receive attention. We shall surely reap what we sow.

It would be desirable could our association agree upon some approximately common method, or methods, of charging for electric current. If one method cannot be considered best, several eventu-

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ally might be recommended, each possessing recognized elements of fairness to the public as well as to the supplying companies.

The "sliding scale," fixing a maximum price and a minimum dividend, is receiving increased attention. It seems to offer advantages in uniting the interests of the public with those of the supplying companies. Its application and range of usefulness may be considered in the report of the public policy committee.

At the last convention in this city the question of pending legislation in the various States of the Union was given consideration. It is to-day a live question. To obtain and send this information to our members seemed almost impossible until one of the reports of the public policy committee became available, which showed not only the practicability of the plan, but how well it could be carried out. Central station managers are usually much engaged with their work, and without notice hostile and unfair legislation may at any time be passed. Were there a method through which every member in a given State could be advised of such measures, combined and united action would go far toward preventing results harmful to the industry and, reactively, to the general public.

The relations with the insurance interests of the country continue pleasant. In expressing his regrets that he could not attend the convention, Mr. G. M. Goddard, secretary of the Underwriters' National Electric Association, says he would enjoy the privilege of meeting many of the representatives of the N. E. L. A. and the representatives of our members, because he believes the relations between the underwriters, who are particularly concerned in the matter of the National Electrical Code, have become in the past few years more and more cordial.

During the year the offices of the Association have been moved from 136 Liberty street to West Thirty-ninth street, near the Grand Central Station and but a block from the new public library. The new offices are in the Engineering Building—through the generosity of Mr. Andrew Carnegie.

In closing it is but fair to say that during the year the secretary's office has been conducted admirably. One not directly connected with the affairs of the Association cannot realize the amount of work done and the responsibility resting upon these offices. Warmest praise is due our secretary and treasurer, Mr. W. C. L. Eglin, and our assistant secretary and treasurer, Miss Harriet Billings.

At the conclusion of President William's address, Mr. W. C. L. Eglin, Secretary of the Association, announced that the Consolidated Gas, Electric Light and Power Company, of Baltimore, extended an invitation to the delegates to visit its new Westport power house. The McCall's Ferry Power Company also invited the convention to visit their plant on the Susquehanna River. Mr. T. Comerford Martin then presented an abstract of the report of the Committee on Progress, giving the central station developments of the past year. Mr. Martin attributed the remarkable electrical development of this country to the wonderful growth and progress of the country itself. It was a process of evolution, as well as an exhibition of enterprise by electrical men. The next paper presented was by Mr. Paul Lupke and read by Mr. Martin. It was entitled "Accidents," and though it brought down the house, no one was hurt. The paper abounded with witty and good advice.

Mr. F. D. Newbury, of Pittsburg, then presented his paper on "Power Factor Correction by Synchronous Motors," pointing out how, in some cases, the bad effects of low power factors may be overcome by the proper application of over-excited synchronous motors. The motors are run without load simply to raise the power factor—as synchronous condensers, in fact. There are three cases in which this practice may be desirable: Where the trouble can be remedied only by the employment of synchoronous condensers; where, in proposed systems, there will be a large inductive load, with large cost for feeders and transforming apparatus and, finally, in proposed systems with large inductive load in which slow-speed generating units, as gas-driven units, will be used. At the conclusion of Mr. Newbury's paper, upon which there was no discussion, Mr. Paul Spencer, of Philadelphia, presented the Question Box, which was prepared by Mr. Lupke. Mr. Lupke suggested the establishment of a Bureau of Information to suggest answers to questions when submitted, and later to present to the Association the questions and answers of general interest. The subject was referred to the incoming administration, with the recommendation that Mr. Lupke's idea be adopted.

Mr. W. H. Blood, Jr., a former President of the Association, and now Insurance Expert of the Association, presented a very valuable and interesting report on insurance and kindred matters. "The Association has for several years," says Mr. Blood,

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"felt that it was handicapped at the annual meetings with the Underwriters' National Electric Association in the consideration of the changes in code rules; that no one took enough personal interest in the proposed changes to discuss them intelligently with the representatives of the underwriters, who made it an important part of their regular business."

"This year your representative spent over a week in preparation for the meeting, and practically a second week in attendance at all of the sessions in New York. Of approximately one thousand proposed changes, only about one hundred were passed, and many of them were of minor importance, or simply improvements in phraseology. It is gratifying to state that your representative was instrumental in preventing the passage of several radical changes which would have worked hardships upon the lighting companies. One rule, in particular, in regard to wiring in show windows, which the Electrical Committee of the Underwriters approved for passage, was resisted by your representative and finally defeated. The passage of this one rule would have meant the loss of hundreds of thousands of dollars to the lighting interests of the country, and would have affected most seriously the small and medium sized companies, which need every dollar of income they can obtain. As a result of the interest shown in these meetings, your representative has been appointed on several committees of the underwriters, to report on further modifications of the rules. One of these committees is to consider the complete remodification of and reclassification of the National Electrical Code. Your representative holds himself in readiness to act upon any suggestions from members of the Association, and to give his services in negotiations with the underwriters in the presentation of new, or the revocation of old rules, in court cases when expert services are required, and, in fact, in all matters pertaining to insurance business."

At the conclusion of Mr. Blood's report, President Arthur Williams stated that the services of Mr. Blood were of the utmost value.

Mr. C. E. Skinner, of Pittsburg, presented the report on the "Fire Hazard of Electricity." At the conclusion of Mr. Skinner's paper, an executive session of the Association was held, after which an adjournment was taken.

On Tuesday afternoon, which was given up to entertainment, there being no afternoon session, the principal event was the special reception of the Association at the White House by President Theodore Roosevelt. Only members and guests wearing badges were admitted to the Executive Mansion. Fully one thousand of the delegates and visitors at the Convention had the honor of shaking hands with the President, who received them in the East Room of the White House.

The Tuesday evening session was devoted principally to a discussion of the report of the Committee on "Electric Light Accounting," presented by Mr. H. M. Edwards, of New York. The report of the committee was most complete and devoted to the discussion of general construction, operating and income accounts, and were treated with various subdivisions and details. The report represented a great deal of very careful work in its preparation, and at the end of it a number of bookkeeping forms were given.

"Legal Justification for Differential Rates," was the subject of the next paper, which was presented by Mr. G. W. Betts, Jr., of New York. Mr. Betts stated that a differential based on a reasonable difference in the cost of producing service is not contrary to law. That the common-law rates should be fair and reasonable, but not necessarily uniform. Statutory enactments may modify this, of course. In relation to differentials based on quantity of current consumed, there is a little doubt, but the speaker thought they were justified. Competition also might modify the question of making differentials. Following Mr. Bett's paper, Mr. Frank Conrad, of Pittsburg, read abstracts from his paper entitled "Commercial Development of the Mercury Rectifier." Mr. DuBois then presented a paper by Mr. D. B. Rushmore, of Schenectady, entitled "Recent Developments in Protective Apparatus." On account of the lateness of the hour, nearly eleven o'clock, no discussion followed either of the last two papers, and the session adjourned. At the opening session Wednesday morning, Mr. Dudley Farrand, of Newark, N. J., presented the report of the committee to consider specifications for street lighting. Mr. Farrand, who was chairman of this committee, was assisted by Dr. A. E. Kennelly of Harvard University; Mr. L. A. Ferguson, of Chicago; Mr. Paul Spencer, of Philadelphia, and Mr. Charles P. Steinmetz, of Schenectady. It was recommended that, under ordinary conditions, all street arc lighting with lamps placed two hundred to six hundred feet apart, specifications should de-

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fine the mean illumination given by each lamp at some point in the street not less than two hundred, nor more than three hundred feet from the lamp, as measured at the height of the observer's eyes and perpendicular to the rays. The illumination at this point shall not be less than that given by a stationary standard incandescent lamp of sixteen candle-power placed at a certain proportion of the distance between the observer and the arc lamp. This proportion is to be fixed in advance by agreement. For instance, it might be one-tenth of the distance separating the observer from the arc lamp. After quite a long discussion, the report was adopted. Mr. L. A. Ferguson motioned that the committee be continued and authorized to fill out the report, with data now lacking, which are supplementary to the report. If, then, the Executive Committee approves the report, it is to be officially promulgated with the approval of the Association. Mr. G. M. Little, of Pittsburg, read his paper on "New Developments in Arc Lamps and High Efficiency Electros." The paper was most interesting, and was based on the new Westinghouse metallic flame-arc lamp, several of which were exhibited burning on the outside of the hotel, and one of them was shown in the meeting room. Two papers and a committee report relating to the subject of the unsatisfactory nature of municipal contracts for street lighting, by Mr. Henry Floy, of New York, and Mr. E. Leavenworth Elliott, of New York, were presented.

During this session, Dr. S. W. Stratton, Director of the Bureau of Standards of the United States Government at Washington, was introduced by President Arthur Williams and addressed the meeting, outlining the work and plans proposed for the future work of the Bureau. "Protection from Lightning and Other Static Disturbances" was the subject of the paper presented by Mr. Alexander Dow, of Detroit, a brief abstract of which was read by his associate, Mr. Robert S. Stewart. Mr. C. D. Wood, Jr., of New York, then presented his paper entitled "Electric Heating without Special Concessions from the Central Stations," which was received with a great deal of interest.

The session of Wednesday evening was opened by an address by Mr. Edward A. Norman, of New York, on the efficiency of various methods of illumination, which was ably discussed by Mr. V. R. Lansingh, one of the greatest authorities in this country on illuminating engineering. The next paper was on "The Frequencies of Flicker at which Variations in Illumination Vanish," by Dr. A. E. Kennelly and Mr. S. E. Whiting, of Harvard University. This paper was abstracted by Dr. Kennelly. Although this paper was distinctly a laboratory lecture, it met with a great deal of interest. Dr. C. P. Steinmetz, the "Wizard of Schenectady," gave one of the most interesting talks on the subject of lightning and lightning protection. At this time the meeting room was crowded, and the keenest interest was shown by everyone. Dr. Steinmetz analyzed the causes that produce lightning in the atmosphere, and described the formation of a lightning flash with all its characteristics, and concluded his talk by describing the methods of protecting electrical circuits and apparatus from lightning discharges. A hearty vote of thanks was given to Dr. Steinmetz at the conclusion of his most interesting talk. At the conclusion of this session, a short executive session was held, and the following were selected as the committee to nominate the officers for the ensuing year. Mr. Henry L. Doherty, of New York; Mr. J. E. Montague, of Niagara Falls; Mr. Percy Ingalls, of Newark; Mr. John F. Gilchrist, of Chicago, and Mr. W. W. Freeman, of Brooklyn. There were two papers on the gas engine presented during Wednesday evening's session, the first by Mr. J. R. Bibbins, of Pittsburg on the "Application of Gas Power to Central Station Work," which was a careful consideration of up-to-date practice in gas engine work. The second paper was by Mr. Lewis Nixon, of New York, entitled "The Future of the Gas Engine." This paper was read by Mr. Wells, of Brooklyn. Mr. Nixon's paper was criticized by several as being rather visionary, but those who know that the word "visionary" is diametrically opposite to the practical make-up of Lewis Nixon, appreciate that it is a comparatively short time before many, if not all, of Mr. Nixon's predications will be facts, there being probably no greater authority on the economical design and construction of steam and gas machinery. Lewis Nixon is a thinker, and not a dreamer.

Another most interesting paper on the subject of gas engines was presented by Mr. Robert T. Lozier, of New York, entitled "Producer Gas Engines for Central Station Work." This paper was illustrated by lantern slides and diagrams, showing gas engine construction, including one of the large gas engine stations in San Francisco, the most important installation in this country. Mr. Lozier's

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paper was the first of the Thursday morning session. Mr. Ernest H. Davis presented his report on Freight Classification. The Association adopted a resolution recommending to the Interstate Commerce Commission that a universal freight classification be adopted. Mr. W. L. R. Emmet, of Schenectady, then presented his very interesting and instructive paper on "Recent Steam Turbine Developments," giving the results of tests of a 9,000 kilowatt turbo-generator in the Fisk Street station, Chicago. The steam economy shown by these tests was higher than any previous result within the same range of temperature and pressure. Subsequent tests in Boston and Schenectady verify the tests above referred to. Mr. Frankenfield read an abstract of his paper on "Balancers vs. Three-Wire Dynamos," which paper was followed by Dr. E. P. Hyde's paper entitled "The Effect of Frosting Incandescent Lamps." Mr. Hyde's investigations showed that from five to six per cent. of the light was absorbed by frosting, and that the life of a frosted lamp was about half that of the ordinary plain bulb.

Mr. Alex Dow, of Detroit, then read portions of a very interesting paper prepared by Miss Sarah M. Sheridan, of the Detroit Edison Company, entitled "Some Electric Power Experiences."

At the opening of Thursday evening's session Mr. J. Robert Crouse, Chairman of the new Membership Committee, gave the results of his short but successful campaign. From March 1 to June 6 Mr. Crouse's energies were rewarded by the addition of 243 new members to the Association.

Mr. H. H. Rice, of Indianapolis, then read a portion of his paper on "Opportunities for the Sale of Current for Charging Electric Automobiles." Mr. Rice claims that this field is what you make it. Thousands will buy electric carriages and the current with which to run them, if given half the encouragement that central station men are now extending to their other current-using devices. This paper was followed by a report by Mr. W. H. Blood, Jr., of oBston, for the Committee on the Grounding of Alternating Current Secondary Circuits. Mr. Blood stated that a joint meeting of the insurance and electrical interests would soon be held, the prevailing opinion being that the secondary alternating current circuits should be grounded, but there were diverged views as to the voltages to be grounded. During this session President Arthur Williams was presented by the exhibitors with a gavel made from the oak from one of the Senate doors of the old Capitol as it stood before its partial burning by the British in 1814. The gavel is mounted with gold, accompanied by a certificate of validity. General Harries, of Washington, presented the gavel to Mr. Williams, who acknowledged it in characteristically graceful terms. During the Thursday evening session, and after a most interesting debate, the report of the Committee on Public Policy was adopted. This committee is a new one in the history of the Association, and its membership represents the lighting interests of the entire country; any subject touching the general relations of the companies to their customers, their employees, the public or the public authorities, in short, whatever involves questions of external, as distinguished from internal policy, is within the scope of the consideration of this committee. The subjects of municipal ownership and of public regulation and control of public utilities are intimately connected with each other. Neither can be adequately discussed without reference to the other. Indeed, one is the alternative of the other. Municipal ownership is demanded largely because of the business of proper public regulations and control. Public regulations and control, if efficient, removes the necessity or excuse for municipal ownership by securing fair treatment for the public. If, however, a system of public regulation and control which is at once fair to the corporate interests involved and efficient in securing results to which the public is equitably entitled, can be evolved and put into operation, municipal ownership can no longer be alleged to be essential to the public interest. What the public wants is efficient and adequate service at fair prices.

At Friday morning's session, a paper by Signor Semenza entitled "Italian Methods of Charging for Electric Service," was presented in abstract by Mr. L. A. Ferguson, at the conclusion of which Mr. Ferguson also gave a short talk on the need for an accurate maximum demand meter for measuring the true value of polyphase service, stating that in Chicago they had found it practically out of the question to use the Wright-Demand meter for measuring current rather than actual power, and if a unit power factor was assumed, it would make the customers' apparent maximum too high. They had determined the ratio of the maximum demand to the connected load at 10,000 horse-power of direct current motors connected to their service, and by making several classifications, had arrived at a

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maximum demand to be assumed for alternating current motors. At the close of the discussion on this subject, it was voted to appoint a committee on meters to consider the subject for another year, and the Chair appointed Mr. L. A. Ferguson, of Chicago; Mr. J. E. Montague, of Niagara Falls, and Mr. Alex Dow, of Detroit. The Committee of Protection from Lighting, submitted a report regarding the damage done by lightning during 1906, and it was found that there had been considerably more trouble during 1906 than the previous year. Practically half of the companies from whom the reports had been received suffered from the burning out of transformers or generators. The transformers damaged were largely of the small, old-fashioned, air-cooled type. Following this report, Mr. Frank Conrad outlined the recent developments of the Mercury Arc Rectifier, as used by central stations.

Friday, the last day of the Convention, and termed, as the last day of subsequent conventions will probably be termed, "Commercial or New Business Day," gave us the plans of the Co-Operative Electrical Development Association, and also its Constitution and By-Laws. During the presentation of these papers, Mr. W. W. Freeman, of Brooklyn, Chairman of the Committee to Assist in the Further Development and Prosecution of the Plans of the Co-Operative Electrical Development Association, presided. Mr. J. Robert Crouse, the father of the whole scheme, and the active worker in the preparation of the "Commercial Day" program, also occupied the platform. All of these valuable papers were bound together and formed unquestionably one of the most valuable of all presented at this convention. The papers making up this "Commercial Program" are too important to be presented by mere abstract, and in turn they will be presented in full in subsequent issues of THE CENTRAL STATION. "How to Get Old Buildings Wired," and "How to Get New Buildings Wired," the former by Mr. F. H. Golding, and the latter by Mr. J. Sheldon Cartwright, will be found in another part of this issue of THE CENTRAL STATION. On Thursday morning the representatives of the various manufacturing companies and electric supply houses met for the purpose of forming a permanent organization to look after the exhibits at future conventions. This organization will have a permanent secretary and exhibition manager, and will work in conjunction with the National Electric Light Association in relieving the latter of the vast amount of detail work necessary in connection with the exhibits at conventions, which work has now assumed such proportions as to necessitate a separate organization for its proper handling. The committee appointed consists of Mr. F. H. Gale, of the General Electric Company; Mr. J. C. McQuiston, of the Westinghouse Electric and Manufacturing Company; Mr. W. B. Hager, of the Allis-Chalmers Company; Mr. Rodman Gilder, of the Crocker-Wheeler Company; Mr. H. M. Post, of the Western Electric Company; Mr. C. P. Frey, of the Weston Electrical Instrument Company, and Mr. C. W. Lee. At the executive session, the following were elected to the various offices of the Association for the coming year:

President, Dudley Farrand, of Newark, N. J.; First Vice-President, Alex Dow, of Detroit, Mich.; Second Vice-President, W. C. L. Eglin, of Philadelphia; Secretary, W. W. Freeman, of Brooklyn.

The Executive Committee will consist of General George H. Harries, of Washington; A. J. DeCamp, of Philadelphia, and Samuel Scovil, of Cleveland.

Convention Notes

The Simplex Electric Heating Co., of Cambridge, Mass., was represented at the convention by Mr. James I. Ayer, president of the company, and former president of the National Electric Light Association. Mr. Ayer was assisted by his lieutenants, Roger Williams, C. A. Flint and P. H. Howard. The exhibition of this company was a very complete line of "Simplex Quality" heating and cooking apparatus, among which were two large electric ranges, by far the best things in electrical cooking apparatus ever produced.

The Holophane Company, of New York, was represented by Mr. V. R. Lansingh, one of the best illuminating engineers in this country.

The D & W Fuse Co., of Providence, was represented by its secretary, Mr. W. S. Sisson. D & W Fuses were exhibited by The Pettingell-Andrews Co., of Boston, and the Western Electric Co., of Chicago and New York, among their other specialties.

American Electrical Works, of Providence, R. I., was represented by its Eastern manager, Mr. Frank Donohoe, of New York.

Weston Electrical Instrument Co., of Newark, N. J., occupied four spaces at the convention which was only large enough to show a partial though

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very interesting line of Weston instruments. They created a great deal of interest among the knowing ones. Those who didn't know did know after their talk with Dr. Weston, who was present much of the time and seemed to take great pleasure in showing his beautiful line of instruments. Dr. Weston was ably assisted by Mr. Charles P. Frey, of the factory, who was responsible for the comprehensive display.

The Excello Arc Lamp Co., of New York, was represented by its president, Mr. H. M. Hirshberg, the man who really introduced New York to the flaming arc lamp, and who is responsible for its great popularity and tremendously increasing use in other cities.

Western Electric Co., of Chicago and New York. had a most interesting and comprehensive exhibit of their lighting specialties, fan motors, etc., in charge of advertising manager, Mr. H. M. Post. The entire lighting of the New Willard Hotel, the headquarters of the convention, is done by four direct-current generators manufactured by this company. A very complete map of the city of Washington was the souvenir presented to each delegate by the Western Electric Co.

Allis-Chalmers Co., of Milwaukee, exhibited by photographs in racks, and by its publications, the vast and varied resources of this big company, which, if it had tried to show its actual apparatus, would have required a space equal to the entire floor area of the New Willard Hotel—and then some. This company was well represented by a large number of its local managers from all over the country.

General Electric Co., of Schenectady and the Universe, took occasion at this convention to introduce its new baby, the Tungsten lamp. A very interesting bulletin on this new creation was distributed, and lest some impertinent questions were forthcoming by the wise or otherwise, Mr. F. H. Gale, manager of the publicity department, fortified himself with no less than the following:

Mr. J. R. Lovejoy, vice-president and sales manager; Mr. Caryl D. Haskins, manager of the lighting department; Dr. C. P. Steinmetz, the man who doesn't have to use a slide rule. Mr. W. L. R. Emmett, the turbine specialist; and Mr. P. D. Wagoner, who has forgotten more about rheostats and starting boxes than most of us know. One glance at this phalanx produced the glad remarks about baby Tungsten—but young Tungsten is all right at that, a little fragile, perhaps, on account of its youth, but it will have a great bunch of trainers from now on. Keep him good and warm; don't let him get cold and handle him gently, and he will soon develop into the light of the family.

Dossert & Co., Inc., of 242 West Forty-first Street, New York, manufacturers of the well-known solderless connectors and terminals for wires and cables, had a prominent place in the center of the exhibition hall, in which they installed an interesting and unique display of their devices. They aroused more than ordinary interest, owing to the radical departure of the National Board of Fire Underwriters recently in amending the code to allow the use of an approved mechanical joint without solder. The exhibit included an imposing array of approved Dossert joints, including 2-Ways Types A and B, front and back terminal lugs, three and four ways, cable taps, motor lead connections, service box plugs, etc. Mr. H. B. Logan, president of the company, was in charge, ably assisted by Mr. E. A. Dossert, sales manager.

The Jandus Electric Company, of Cleveland, O., had a very large display of their arc lamps.

The Electric Storage Battery Company, of Philadelphia, was represented by its manager of sales, Mr. Charles Blizzard, who is also third vice-president of the company. Mr. Blizzard was assisted in explaining the merits of chloride accumulators and the company's new type of end-cell switch, and automatic hydrometers, by Mr. A. H. Ackerman, of the New York office, and by Mr. E. L. Reynolds, manager of the Pennsylvania sales office.

The Franklin Electric Manufacturing Company, of Hartford, Conn., had an independent exhibit of its own, in which were shown the Franklin Gem, the Franklin Tantalum, Femco and Novi incandescent lamps, which were fitted with Holophane reflectors. This exhibit was in charge of Assistant Manager, Mr. P. S. Klees, who was assisted by Mr. C. Leonard, manager of the Baltimore office; Mr. C. N. Thorpe, manager of the Chicago office; Mr. G. O. Curtis, manager of the Buffalo office, and Mr. T. G. Truitt, their Pennsylvania representative.

Wagner Electric Manufacturing Company, of St. Louis, exhibited variable speed single-phase motors, used in connection with ventilating fans and also adapted to pumps, printing presses and machine tools. This company also had in operation at their exhibit their new type standard single-phase motor, as well as a complete line of indicating instru-

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ments for both alternating and direct currents. Mr. W. Robbins, assistant general manager of the company, was in charge of the exhibit.

The National Metal Molding Company, of Pittsburg, manufacturers of "Economy," and "Flexduct" interior conduits, was represented at the convention by Mr. C. E. Corrigan and Mr. Harry Kirkland.

An exhibition of fiber conduit and fittings, with elbows, junction boxes, crosses, etc., made of the same material, was the exhibition made by the Fibre Conduit Company, of Orangeburg, N. Y. Sales Manager Mr. W. K. Sparrow was in charge of the exhibit, assisted by Mr. F. A. Curtis and Mr. S. G. Thompson.

American Electrical Heater Company, of Detroit, Mich., represented by its president, Mr. B. H. Scranton, and its secretary, Mr. Robert Kuhn, displayed nearly two hundred varieties in electrical heating apparatus.

The National Carbon Company, of Cleveland, O., was represented by General Sales Manager Mr. N. C. Cotabish, Assistant Manager of Sales; Mr. E. J. Kerlin, and Secretary Mr. J. S. Crider.

Mr. Hugo Reisinger, of New York City, the largest importer of high grade carbons in this country, whose product received the Grand Prize at the St. Louis World's Fair in 1904, was represented at the convention by Mr. C. A. DuBosch.

The Okonite Company, of New York, was represented by its general manager, Mr. George T. Manson.

The Curtis Advertising Company, of Detroit, the concern that knows how to write business-getting literature, had a very interesting exhibit of what it has done in this important line to central stations.

The Dale Company, which started in a small loft up three rickety flights of stairs on Greenwich Street, in New York City in 1897, and which, in ten years, has grown to be one of the largest manufacturers of wireless clusters and electrical fixtures in the world, now occupying a large building bordered by Ninth Avenue, Thirteenth and Hudson Streets, was represented by the man whose business ability was responsible for its remarkable growth, President John H. Dale, the Beau Brummel of the Convention.

The Oneida Community, of Oneida, N. Y., manufacturers of Oneida galvanized chains for arc lamp suspension, had a very interesting exhibit of this product, which is now being universally adopted for arc lamp suspension in electric lighting stations generally all over the world. Fob chains made of their standard material were distributed as souvenirs and were much in demand.

The American Electrical Instrument Company, of Philadelphia, was represented by President James G. Biddle, Mr. D. S. DeCou and Mr. T. G. Seixas, of the New York office.

The Moline Incandescent Lamp Company, of Moline, Ill., was represented by Sales Manager Mr. C. R. Wood. Mr. Wood, exhibited the new Moline metallic filament lamp, which has met with such favor already throughout the Middle West.

H. W. Johns-Manville Company, of New York City, exhibited a complete line of their electrical specialties and line material, including a splendid display of "Noark" fuses. Mr. J. W. Perry, manager of this department of the company, assisted by many of his sub-managers of different parts of the country, was present.

Crouse-Hinds Company, of Syracuse, N. Y., devoted their space in the Exhibition Hall to a large display of the various types of "Condulets." The company was represented by Mr. A. F. Hills, of Syracuse, and Mr. Frank M. Hawkins, manager of the New York office. No new wiring device ever jumped quite so forcibly into universal favor and use for interior and exterior construction work as "Condulets." It has revolutionized and standardized wiring construction work generally.

The Brilliant Electric Company, of Cleveland, O., was represented by its general manager, Mr. E. J. Kulas, oppressively quiet and dignified. Nobody yet has guessed her name.

The most striking and brilliant exhibit at the convention was that of the National Electric Lamp Association. It was one blaze of advancement in the art of incandescent lamp making. Arched above this space were lines of the new Tungsten lamp, and their exhibition space was lined with the latest developments in Tantalum and Gem metalized filament lamps. The new Tungsten lamp and the old style carbon lamps were connected up in this exhibit with a wattmeter and a voltmeter, to show the relative economies of the two styles. Tungsten and ordinary carbon filament lamps of 40 and 50 watts respectively, connected in multiple circuits in series with a rheostat, were shown. By aid of the rheostat, it was possible to observe the effect of the change of voltage on these two makes of

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lamps. This method showed that the resistance of the Tungsten lamps increases with the increase of temperature, whereas the resistance of the old type of carbon filament lamp decreases with the increase of temperature.

Four adjoining spaces in the Exhibition Hall were occupied by the Westinghouse Companies. The Westinghouse Electric and Manufacturing Company, Westinghouse Lamp Company, Nernst Lamp Company and the Westinghouse Machine Company. The new direct current series arc lamp made its first public appearance at this convention. Eight of them were shown in series, taking four amperes and fifty volts each. The Westinghouse Lamp Company, formerly the Sawyer-Man Electric Company, exhibited a number of its high efficiency metalized filament lamps in candle powers of from 20 to 50, at a voltage of 110. The Westinghouse Electric and Manufacturing Company showed a complete line of switchboard and portable instruments, including their graphic recording voltmeters, ammeters and wattmeters. The latest types of circuit breakers and fan motors for both alternating and direct currents were also exhibited. Several types of the latest developments in enclosed arc lamps were also exhibited by the Westinghouse Electric and Manufacturing Company. The Nernst Lamp Company exhibited their latest type, which is a 115 candle power lamp, consuming 110 watts, so constructed as to throw all its useful rays in a downward direction. This lamp created a great deal of attention. Several three-glower ceiling fixture Nernst lamps were shown in connection with Holophane hemispheres. Six-glower lamps of the same make were also exhibited. The Westinghouse Machine Company exhibited several sizes of their new storage battery plates which are now being furnished to street railway power stations, lighting plants, signaling and train lighting. An unusually strong battalion of the Westinghouse forces was on hand to answer the many questions asked by the host of interested delegates. Among those present were Vice-President G. M. Bates, Mr. J. C. McQuiston, manager of the publicity department, and about twelve other representatives from the various departments and territories of the Westinghouse Companies.

The H. B. Camp Company and the American Vitrified Conduit Company were represented by Mr. C. C. Baird, the smiling and order-securing countenance of Mr. Stephen Douglas being used at the Telephone Convention in Chicago at the time Mr. Baird was attending our convention in Washington. As usual, the most sought-after souvenir was that given away by the H. B. Camp Company, which consisted of a business-like looking watch which required but one horse power hour for its winding. Hand ratchets were provided, however, for this purpose, which proved equally effective where a bench vice was convenient, in which to secure the time-piece during the winding operation. It was the "hit" of the convention at that.

Mr. John L. Gleason, of Jamaica Plain, Mass., exhibited his well-known molding boxes, invented and manufactured by himself, together with a line of Fancleve electrical specialties, which are now becoming standard in construction work generally.

The Crocker-Wheeler Company, of Ampere, N. J., exhibited in its space a most interesting collection of photographs of Crocker-Wheeler installations for all classes of manufacturing, lighting and power purposes. Mr. Rodman Gilder, assisted by the district manager of the company, answered the many inquiries which this collection of photographs brought forth.

The Bryan-Marsh Company was represented by its staid old philosopher of the New York office, George Diogenes Lockwood, the stoic of the Eastern district, and by Mr. Ernest H. Haughton, manager of the Chicago office. Ernest fooled us all this trip, as there was not a single fountain, elevator or chandelier missing when he received his clearance papers from the management of the New Willard Hotel upon his departure for Chicago.

Harry C. Rice, vice-president of the General Incandescent Lamp Company, of Cleveland, O., was present during the entire convention, with a brand new line of stories. When Harry gave us his imitation of a little dog under the table, there wasn't a dry seat in the house.

The Buckeye Electrical Company was represented by Mr. L. P. Sawyer, the Don Juan of the Lamp Association.

Mr. James C. Wormley, president of the Downward Light Electric Company, put in an appearance on the last day of the convention, having just completed a very successful business trip throughout the West.

The Standard Vitrified Conduit Company, of New York City, had a very interesting and complete exhibit of its vitrified conduits, and was represented by Capt. B. S. Barnard, president of the company.

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The annual capacity of Mr. Barnard's company is 40,000,000 duct feet of conduit. Captain Barnard has sold to the city of Baltimore alone during the past ten years over 16,000,000 duct feet of his conduit.

Pettingell-Andrews Company, the largest electrical supply house in the world, exhibited several of its latest lighting specialties, the one creating the most interest being the remote control switches for direct and alternating currents.

The Phoenix Glass Company, of New York, Pittsburg, and Chicago, was represented by Vice-President A. H. Patterson.

The Fostoria Incandescent Lamp Company was represented by its manager of sales, Mr. H. H. Geary.

Mr. B. G. Tremaine and Mr. F. S. Terry, of the National Electric Lamp Company, arrived on Thursday and remained until the close of the convention.

An interesting line of transformers, meters, fan motors, small motors and arc lamps exhibited by the Fort Wayne Electric Works, of Fort Wayne, Ind., in charge of Sales Manager Mr. F. S. Hunting and Assistant Sales Manager Mr. A. A. Serva. Several other representatives from the branch offices of this company were also in attendance.

The Emerson Electric Manufacturing Company of St. Louis, famous for its line of small motors, was represented by Mr. H. L. Parker, president of the company.

The Stirling Electrical Manufacturing Company, of Warren, O., was represented by Old King Coale, the manager of the company, who never forgets that he has a reputation to live up to.

The Shelby Electric Company, of Shelby, O., makers of the Shelby useful light lamps, was represented, in the absence of President J. C. Fish, by Mr. W. N. MacBeth, of the Philadelphia office.

The Chase-Shawmut Company, of Newburyport, Mass., was represented by Mr. Masterson and Mr. Moore.

The Columbia Incandescent Lamp Company, of St. Louis, Mo., was represented by its president, Mr. A. C. Garrison.

Mr. H. H. Albert, general sales manager of the Standard Electrical Manufacturing Company, of Niles, O., represented his company during the convention.

The John A. Roebling's Son's Company, of Trenton, N. J., was represented by Mr. H. L. Shippy, Mr. G. W. Swan, and Mr. A. Mann.

American Circular Loom Company, of Chelsea, Mass., manufacturers of "Circular Loom" and "Electroduct," was represented by Mr. A. T. Clark, Mr. Oscar Hoppe and Mr. Alexander Henderson. "Alex," unlike his friend "Sandy" McPherson, was never known to stop pouring when you say "when." The fact is, "Alex" would rather have you pour it yourself.

Mr. G. M. Gest, the expert subway engineer and contractor, of New York and Cincinnati, had on exhibition a number of interesting photographs showing many of his big subway contracts in the course of installation. Mr. Gest's patented cable rack for the support of wires in conduit man-holes was also exhibited. Mr. Gest's interests were looked after by Mr. W. T. Jackson, of the Cincinnati office, until his arrival at the convention on Thursday.

The Pittsburg Transformer Company, of Pittsburg, Pa., showed four of their interesting types of transformers, from one kilowatt to one hundred kilowatt capacity. The two larger transformers were for high tension work.

Mr. F. C. Sutter, Mr. R. V. Bingay and Mr. H. G. Steele, were in attendance throughout the entire convention.

The New York Beck Lamp Company exhibited in operation several of their direct and alternating current American Beck Flaming Arc Lamps, which, on account of their simplicity and beautiful workmanship, which were most interestingly and clearly explained by Mr. J. H. Hallberg, the engineer of the company, and by Mr. H. B. Coles, created a great deal of attention and were one of the spectacular features of the convention.

Central Station Light, Heat and Power Principles

By Newton Harrison.

Central Stations and the Incandescent Lamp.—Much of the development of electric plants in the United States is directly attributable to the incandescent lamp. In the beginning, nearly all the electric lighting was done by its means, and the extensive use of electricity was divided up between the arc and incandescent lamp and very few motors. Arc lights were employed solely for outdoor illu-

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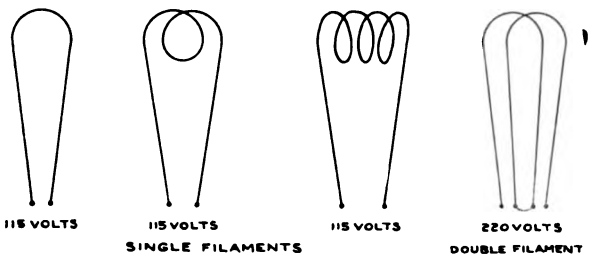
mination, and while representing a good quota of such electric lighting as was done in the early days, it belonged to quite a distinct and undeveloped field. The incandescent lamp, however, has passed through evolutionary processes of manufacture as well, and its origination, first appearance and final stage of manufacture will be recorded from scientific, commercial and economic standpoint.



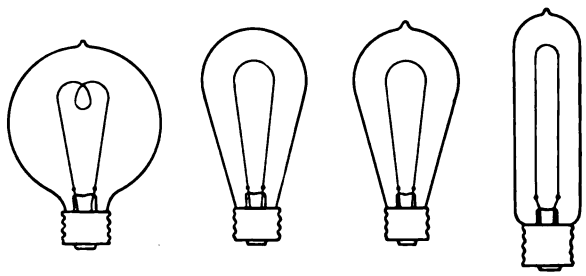
SOME TYPES OF CARBON FILAMENTS.

First Experiments.—The heating of a wire in a glass bulb, from which air had been removed, led to the further experiment of exhausting the bulb still more and noting the increased brilliancy and durability of the wire under these conditions. The glass bulb supplied with electrodes was used in physical laboratories for the purpose of demonstrating the peculiarities of a static charge in a vacuum. The need of an air pump of a better quality than those composed of a cylinder and piston led to the invention of the mercury vacuum pump. In this device a much higher vacuum than that ordinarily obtained was secured by letting mercury drop down a tube to which the bulb to be exhausted wa attached. Globules of air were removed in this manner until by continuing the process the air in the bulb was reduced to what is now called so many milimeters or parts of a millimeter exhaustion, or a hundredth, thousandth or mililonth of an atmosphere as the case may be.

The improved method of getting a good vacuum stimulated inquiry in the inventive field with regard to the incandescent lamp. A high resistance wire was employed, the heating of which meant a certain amount of light. The light was brighter the more current was sent through the wire until a point of volatilization was reached. This experiment of raising platinum wire to a high point of incandescence which gave rise to a brilliant light though of a temporary and expensive nature led to efforts to make the device more permanent as a light giver. Thomas A. Edison's name in the United States and Swan's in England are connected with this stage of its history, and it is curious to note how their experiments in many respects parallel each other, although the Atlantic Ocean lay between the two laboratories and great secrecy attended the work of each.

The platinum wire proposition was rejected after a while, also the hope of using metallic alloys of any description for a filament. The vacuum served to free the wire from the presence of oxygen and the effects of the radiation of the heat into the air which would otherwise be surrounding it. But though an indispensable precaution, the wire filament even under these advantageous conditions could not long resist the high temperature due to the current and its resistance. Edison followed the idea that a filament must be made with a grain if composed of carbon. Swan believed the filament must be homogeneous if its properties were to give durability. Thus operating on different lines of investigation, one discovered in bamboo a good material, when carbonized from which filaments from lamps could be made. The other treated threads with acid and with subsequent carbonization accomplished equally good results.

Why Carbon is Employed.—The use of carbon for a lamp filament was in itself a discovery of no mean importance. It was led up to, as the result of conclusions arising from considerations of tem-



SOME STYLES OF BULBS.

perature and vacuum. The metals melt and volatilize readily beyond a certain degree of heat. Carbon on the other hand, is very difficult to soften by heat, and its volatilization takes place in a very slow and limited manner. Carbon is thus specially adapted to fill a unique field in this respect, for the additional reason that the high temperature will not lead to its destruction unless carried beyond a certain high danger point, nor will it become consumed unless air is present.

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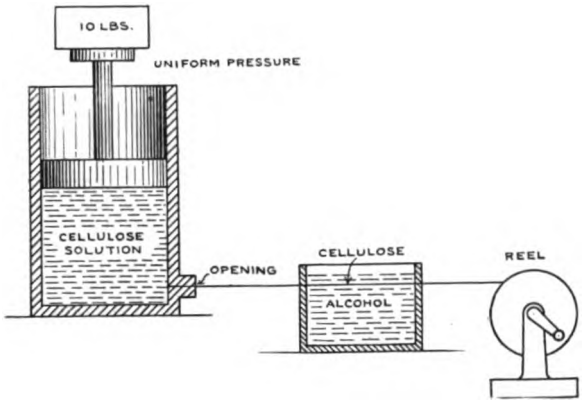
Holding the current in check and heating the carbon in a good vacuum thus expressed the correct working conditions. Another reason why carbon is peculiarly suitable to this purpose is its high resistance. Although the question of its resistance is by

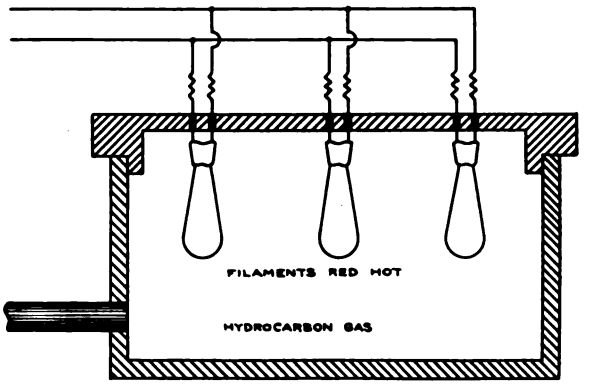


MAKING LAMP FILAMENTS FROM A SOLUTION.

far the most imporant in respect to its current consumption, etc., the fact that its resistance rapidly *lowers* with each fresh access of current is one of the strongest arguments against it. But in other respects it is incomparably better than metals of any description, although of late certain rare metal oxides have been introduced successfully for incandescent lamp manufacture. Maxim used paper to make filaments from and Edward Weston employed a cellulose compound.

Whatever the direction of past or present experiments may be, the fact remains that a certain length of carbon filament is required to consume a certain amount of power. Under these conditions a certain amount of heat and light will be generated. One horse-power of electrical energy produces enough light and heat by passing through lamp filaments to give from 160 to nearly 300 candle-power. In other words, a long carbon filament could be inserted in a long glass tube, exhausted like a lamp bulb, and its length and light could be regarded as a fair standard of the results to be obtained from a detached series of lamps under ordinary conditions of practice. The filament is thus merely a heat machine transforming electrical into thermal and thermal into light energy.

Filament Manufacture from a Solution.—The original methods of making filaments have naturally undergone radical improvement. The bamboo strip is no longer employed, neither is the thread treated with acids, but a semi-liquid or viscous nitro-cellulose solution has taken the place of nearly all of the former filament bases. This is a product obtained by definite chemical processes, and is untilized by forcing it through an aperture in a die or plate from which it issues as a fine thread-like length of translucent material. A vessel of alcohol receives this extending filament, affecting it sufficiently to harden it so that it may be reeled and may be laid away as stock for future use. The most evident of the chemical salts present in the filament, which must be absolutely removed by persistent washing is zinc chloride. A review of the process shows that one of the serious difficulties met with are air cells or bubbles of varying sizes. These are partially obviated by agitating or stirring the solution, but in spite of all precautions their presence is a constant menace to ultimate success. One of the remedies employed is heat in a vacuum retort, but this must be most judiciously regulated or the solution will suffer permanent injury. The filament thread, after being thus prepared, is of the general appearance and strength though of less diameter than a silk violin E string, or the material used for holding fish hooks to lines, the next step in the process is that of cutting up the material into certain lengths preparatory to the carbonizing process. The technical term "squirting" is given this method of manufacture, which has become in many respects the generally adopted plan. Various substances were orig-



FLASHING PROCESS.

inally tried for the purpose of making a pure and comparatively inexpensive cellulose useful for this purpose; they resulted in the ultimate choice of absorbent cotton, a specially picked and prepared as well as readily available foundation. For mere purposes of comparison it may be stated that the most expensive product in the world is a pound of carbon

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filaments complete. Hair springs for watches cost less in price a pound, though it is still the popular idea that in this respect they stand first.

Carbonizing the Filament.—The care exercised in carrying out the process of carbonization belongs to one of the most delicate processes in connection with incandescent lamp manufacture. Powdered charcoal is used as a bed and covering for the horseshoes length and direct contact with the air is carefully prevented during a long period. The oven in which the future filaments are to be reduced, is gradually raised to such a temperature that they all become red hot. It is evident that the oxygen of the air would rapidly convert the entire mass into ash, if permitted to act directly upon it. The charcoal acts very effectively in holding any such tendencies in check. When removed the filaments are hard and elastic and appear like fine steel wires. It is supposed that the carbon of which they are composed is of very fine grain, perfectly homogeneous and of an average resistance throughout. Tests have shown serious differences between filaments in this respect, however, and individual filaments are not sufficiently uniform in structure to be ready for immediate use. The practice, therefore, of flashing represents one of the important preliminaries to the final completion of the filament.

The Process of Flashing.—A microscopic examination of the newly carbonized filaments showed great differences in diameter at various parts of the filament, and the presence of open pores. The idea was suggested, therefore, of heating the filament to redness, while exposed to the influence of a gas containing carbon. The advantage of this lies in the fact that the carbon of the gas will be deposited wherever the filament is unduly heated and otherwise it will form a uniform coating, thus removing the drawbacks noted.

Glass receivers, holding a hydro-carbon gas, such as the vapor of naphtha for instance, are so mounted, that the filaments to be exposed to the flashing process, can be conveniently inserted and treated with the current, all uneven spots in the filaments thus undergo the effects of this method of establishing uniformity. The greater heat at the lesser diameters, means a heavier deposit of carbon there than at other points in the filament The pores fill equally, and the filament when withdrawn, assumes a metallic luster and springiness which are regarded as its chief characteristics.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Electric Lighting and Power Companies and the Police Power

This part of our subject is one of the most important yet treated. It will become still more important as population increases and as the development of uses for electrical energy multiply the avenues for the utilizing of this power. Competition and also the lack it it will produce calls for public regulation of persons, firms and corporations engaged in supplying electric power. Fifty years ago but little thought was given to the public control of common carriers, to-day it is the all-absorbing topic. Manifestation of power in the electric current is as much in its infancy to-day so far as utilization and comprehension of it is concerned as was the railroad problem in 1857, and as with the railroads time is not far distant when demand will be made for the regulation of producers and carriers of electrical energy. Legislatures will be called upon to establish rules and provide commissions to adjust differences between competing companies and when there is no competition, fix rates and adjust differences between the light and power companies, and their customers or the public.

Even now there is regulation in cities by ordinance and the like; and this is but the beginning of what may be expected on a much larger scale within the next half century. Consequently the excuse for our initial assertion of the importance of the field which we are entering. It will not do to point

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out the general desire of the public for the growth of the business under discussion, nor will it suffice to call attention to its great public service or its popularity. All this and even more could be claimed for the railroad business in its early history. It is inevitable wise management may postpone but cannot avert general public control. Discreet management may, however, produce what does not now exist in the case of the railroad interests that is friendly as opposed to hostile control. These last words are perhaps not strictly within the scope of a law article, but are dictated by a study of the railroad problem, by a familiarity with railroad chiefs and by experience in railroad legislation. One thought is dictated by these considerations. So conduct the business as to produce public satisfaction. Strive not to pay exorbitant dividends, avoid overcapitalization. This may not be productive of great immediate profits, but will insure in time a larger dividend. Failure upon these points has done more than anything else to cause the present public distrust of railroad and other corporate enterprises. Men in charge of a corporation, which as an entity does not die, must regard the future as equal if not of greater moment than the present.

The true basis of public regulation is necessity, and it ought not to be resorted to unless necessary to conserve public safety or public rights. The true basis of the power to regulate is the fact that a corporation exists only through public authority and is authorized to exercise franchises only by the sovereign will. Since the State then has created this entity it may govern its actions, and since it has given it its franchises it may prescribe the manner of their exercise. This power is called the police power and its definition is impossible, as its manifestations are legion. It is the authority to preserve order and includes the major part of the sovereign power of the State, it knows no limits but the Constitution, and it is generally held that it may not be bartered away nor hampered by contractual limitations.

As was said by the Federal Supreme Court in New Orleans Gas Co. v. Louisiana Light Co. 115 U. S., 650,671. "The grant of exclusive privileges to the plaintiff does not restrict the power of the State, or of the municipal government of New Orleans, acting under authority for that purpose, to establish and enforce regulations which are not inconsistent with the essential rights granted by plaintiff's charter, which may be necessary for the protection of the public against injury whether arising from want of due care in the conduct of its business, or from an improper use of the streets in laying gas pipes, or from the failure of the grantee to furnish gas of the required quality and amount. The Constitutional prohibition upon State laws impairing the obligation of contracts does not restrict the power of the State to protect the public health, the public morals or the public safety, as the one or the other may be involved in the execution of such contracts, rights and privileges arising from contracts with the State, are subject to regulation for the protection of the public health, the public morals and the public safety, in the same sense and to the same extent, as are all contracts and all property whether owned by natural persons or corporations."

Nevertheless, it may not be gathered from this that no part of the powers of the State or of those delegated by it to municipalities may not be bartered away, for when a franchise confers the power to fix the rate at which the product of the company or its service may be sold, this confers a very broad power upon the company and limits the authority of the public that is the franchise agreement that the franchise may fix the rate is a contract which is protected from impairment by the Federal Constitution. State, St. Louis v. Laclede Gaslight Co., 102 Mo., 472. In this case a municipal franchise gave the defendant the power to regulate the price of gas furnished by it and the court held that this prevented public regulation. It may well be doubted, however, whether this decision would protect a company in charging an unreasonably high rate. Nevertheless it must be conceded as will subsequently appear, that the power to regulate rates may, in a large measure, be relinquished.

Franchise Rights—Right to Use Subway

In this case it appeared that a franchise was granted to the American Electric Manufacturing Co. under which it was authorized to erect poles and string wires in the streets of New York City. This company conveyed its franchises to Frederick E. Townsend, who in turn sold to the American Electric Illuminating Co. The poles and wires of this company were cut down and removed by the public authorities and business was sold at receiver's sale to Martin Minturn, and by him sold to the Long Acre Light and Power Co., who now seek an allotment of subway space.

Upon these facts the Court said, in part:

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"The record shows that the American Electric Illuminating Company, claiming and owning no better right to do so than the franchise in question, and the title thereto, through the assignment to Townsend, did in fact erect poles in the streets of the city and string wires thereon, and supply electricity to its customers by means of such poles and wires, and continue to do so until the completion of respondent's subways, and the forcible removal by the public authorities of all the poles and overhead wires then maintained in the more populous section of the city in Manhattan Island. Unless the American Electric Illuminating Company had municipal authority to erect poles and string wires, these structures constituted illegal obstructions, which it was the duty of the municipal authorities to remove. We are not to presume that public officers wilfully fail to do their duty, and, in view of the acute public and official opposition at that time to the maintenance of overhead wires, we should find it difficult to believe that the public authorities stood by and permitted a wholly unauthorized company to add to the unsightly structures then generally condemned, and permitted the company to expend its money in erecting such structures. Of course, we do not intend or undertake to pass upon any question that may arise between the city and the relator, but the acquiescence of the city in the acts of the illuminating company appear to indicate *prima facie* a ratification of and consent to the devolution upon that company of the title to the franchise originally given to the manufacturing company, and if the illuminating company, when its poles and wires had been cut down, had at once applied for space in the subway, we much doubt whether it could have been denied.

"We are next brought to consider whether the respondent is in a position to call into question the validity of the relator's title to the special franchise in question. The respondent is a private corporation, operating for its own gain. The contracts between it and the commissioners of electrical subways, as well as the act ratifying these contracts, are replete with provisions designed to prevent the monopolization of the subways. The respondent is invested with no authority to grant or withhold privileges, or to discriminate between rival applicants for space in its conduits. It is vested with no governmental functions, and represents in no sense the public either of the state or the city. Whether or not a special franchise may be assigned is a matter of public, and not of private, concern. Such an assignment is not *malum in se*, and the only ground for ever questioning the assignability of such a franchise is that the public were interested in its exercise by the original grantee. Accordingly, it has been held that only the public may question the validity of an attempted assignment, and that it is not a question to be raised collaterally or by any private individual. Thompson on Corpns. vol. 4, par. 5367; Oakland R. Co. v. Oakland, etc., R. Co., 45 Cal. 365, 13 Am. Rep. 181. A similar rule has uniformly been applied as to the right to question the validity of a company's incorporation, a closely analogous question. Thus, where an attempt has been made to create a corporation by papers with the color of law, but so far defective in execution that they would be held, in a direct proceeding, to be defective and ineffectual, and the corporation has exercised its corporate powers, it is well established that the corporation is safe from collateral attack by any person by reason of its defective incorporation, and can be directly attacked only by the state. Lamming v. Galusha, 81 Hun, 247, 30 N. Y. Supp. 767; Buff. & Atl. R. Co. v. Cary, 26 N. Y. 75; Eaton v. Aspinwall, 19 N. Y. 119. The relator stands in this precise position. It holds the franchise to operate under a formal assignment from the original grantee, and its predecessor in title, holding under the same assignment, actually exercised the privilege conferred by the franchise. We do not, of course, hold that the respondent is obliged to assign space in its conduits to every one who may apply, or that it may not, before assigning such space, inquire whether the applicant has a right to enter, but we are of opinion that when application is made by a corporation having apparent right to a franchise, and which has actually, with the acquiescence of the public authorities, exercised the franchise, the validity of its right and title is not open to collateral attack. If, for any public reason, there is a doubt as to the validity of the title, that question can be raised by the proper municipal authority when application is made for a permit. If not then raised, the question is of no concern to the respondent. That the franchise was assigned in the first instance to an individual does not suggest any defect in the chain of title. We are not aware of any statutory or inherent reason why the right to construct and maintain electrical conductors may not be conferred upon an individual, and none has been suggested. At all events, Townsend, the assignee, never attempted to

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use the franchise, but seems to have served merely as a conduit through whom the franchise passed from one company to another. Such a method of transfer is not invalid. Parker v. Elmira, C. & N. R. R. Co., 165 N. Y. 274-280, 59 N. E. 81. Before actually stringing its wires, it is necessary that relator shall have not only an allotment of space, but also a permit from the commissioner of water supply, gas and electricity. It seems to be quite unimportant which is applied for first, and would be of no importance whatever, were it not for the rules made by the commissioner of water supply, gas and electricity governing such application. These rules cover both applications for leave to construct subways and for leave to enter subways already constructed. As to the latter, rule 3, read upon the motion, is applicable. It is subdivided into two parts, designated "a" and "b." Subdivision "a" requires that application for space must be made to the subway company and certain particulars given. Subdivision "b" reads as follows:

"'When applications have been made and space assigned for conduits under ground, the written consent of the Commissioners must be obtained before any conductors are placed in the space so assigned.'

"If the relator had applied to the commissioners before he obtained an allotment of space, his application might well have been, and doubtless would have been, refused under this rule. The unverified letter of the deputy commissioner that a contrary rule has obtained in practice cannot be considered in contradiction of the plain letter of the rule.

"It is also suggested that the special franchise itself requires certain plans to be approved before the franchise can be operated. The grant was of the right to erect poles and hang wires thereon, as well as to place wires underground, and provided that all should be done 'according to such plan as may be directed, approved or allowed by and subject to the power of the electrical subway commissioners.' If the relator were applying for leave to construct conduits for its wires, it would undoubtedly be required to construct them under approved plans; but this is not what it asks. It wishes to draw wires through conduits already constructed according to plans which have been directed, approved, and allowed by the subway commissioners, which is precisely what the franchise calls for. It is stated in an affidavit included in the papers read in opposition to the motion that there are not sufficient subways constructed in the locality requested by the relator, and that, if this application were granted, additional subways would necessarily have to be constructed, for which under the statute the relator would be obliged to give a bond. It is not asserted that any such bond has been demanded, and it is made quite clear that the respondent does not rely upon this objection to relator's application because it is stated in the same affidavit made by respondent's superintendent, that "the sole reason why the respondent has refused to comply with the request of the relator is that neither has the relator been duly authorized to conduct the electric light business in the city of New York either by legislative act, or administrative act, nor is the respondent empowered by law to allot space in its subways upon the application made'; and in the formal answer by respondent to relator's petition it is not alleged, as a reason why the mandamus should not issue, that there are no available ducts. Hence, the existence of available ducts is not put in issue. In any event, the commissioner of water supply, gas and electricity has power to order new conduits to be constructed, and it appears by his own rules that he will do so when, and if, he is satisfied that the unused facilities of existing subways are insufficient to meet existing requirements.

"We are of opinion, that as against the respondent, the relator has established its right to the allotment of space in the conduits, and the order appealed from is therefore affirmed, with $10 costs and disbursements."

Second-Hand Edison Lamp Ruling

A permanent injunction has been issued by the United States Circuit Court, District of New Jersey, restraining William F. McKeon and Joseph Conning, of Newark, N. J., from selling second-hand incandescent lamps unless marked "Used and Second-Hand." The decision signed by Judge Cross, ends a litigation between the General Electric Company and the defendant which had extended over a period of three years.

Similar suits were instituted, one against Edward Mills, proprietor of the Newark Electrical Supply Co., and the other against Frederick W. Chase, proprietor of the Lamp Supply Company, of New York. Neither of these parties defended, and decrees were therefore taken against them by default.

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Lighting a City

The systems employed for lighting a city, have gradually resolved themselves down to a few which are broadly accepted as basic. They belong to a category which fortunately furnishes a fair priced light and the possibilities of improvement. The lighting of a city is thus the result or outcome of enormous previous expenditures in other instances, which led to definite conclusions regarding the best system or systems to install.

Taking the case of a vast metropolis like New York, the variety and cost of electric lighting are items of interest and importance to statisticians and students. The variety may be represented by systems such as: arc lighting, high tension and low, enclosed and flaming; incandescent lights of all voltages, but mainly 115, including several varieties of filaments; rare oxide lamps like the Nernst; mercury vapor lamps and vacuum tube equipments. The competitive struggle is keen, to place one or the other foremost in the field. In fact, the city is peculiarly the arena in which the gladiatorial struggle for commercial supremacy takes place between the backers of different lighting systems. What the final result will be cannot be accurately predetermined, because of the wonderfully creative power of the human mind in inventive fields. If the past is any index of the future, then marked if not radical changes are bound to transpire in the apparatus and naturally in the systems they embody. The tendency is now two fold, to a marked degree. Inventors are straining every nerve to place a lamp on the market which is cheap and a better light giver than the last; and they are systematizing their labors into such a form that another effort attempted, is greater simplicity.

To get more light from the same power is the first proposition; and to reduce the elements of the lighting plant is the second proposition. It is easy to see that apart from the facts thus presented, the idea running current through it all is more efficiency.

The efficiency is of prime importance because of the thought it represents not only in a business sense, but in that of science as well. For instance, a rough estimate of the cost of one night's electric lighting in New York City in the Borough of Manhattan is about $50,000, which would naturally vary with the seasons and represent an increasing sum each year as the illumination increases. At this figure, the electric light bill would be in the neighborhood of $19,000,000 per annum including everything. This of course is subject to criticism and revision, but it gives at least an idea of what an industry it has become and what it will become when all the homes in side streets and humbler parts of the city use electricity instead of gas.

About 2,500,000 incandescent lamps are in use and about 35,000 arcs in the main and well lit body of the city proper. The arcs of course are pretty well distributed and cover quite an area of the city. but the smaller lamps are more or less centered in groups comprising in total one large group more or less concentrated. The ragged edges of this electric constellation are being constantly added to by

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new customers, and the degree of light concentration is thus constantly increasing. It may be possible, that as a law has been passed regulating the internal hygiene of homes, it may also become necessary to do likewise with regard to the light in streets. A minimum candle-power there, would be the means of greatly aiding in the increase of illumination desirable throughout the city. Crime in streets badly lit, would be gradually if not wholly exterminated, for that at least thrives best, not only in deserted, but in badly lighted vicinities.

Lighting a city is not as great a problem as it was when gas was first introduced, and electricity was a questionable feature. Where millions of lamps are involved and millions of dollars as well, gains in efficiency and simplicity are of interest as well as importance.

Comparative Cheapness of Electric Signs

In some, if not many instances, the advertising idea is a dominant one, in the ultimate business success of a firm. As far as the central station is concerned, it is purely in the interest of more extended lighting, that it touches upon the subject at all. But the later developments of both business life and electric lighting have been illustrative of the wedding together of the two interests to a greater extent than was ever anticipated. This has become evident to a marked extent in the use and value of the so-called electric sign, so prevalent in large cities.

There are several points to be advanced and to a certain extent discussed, in this brief view of the subject. Naturally the first is that of cost; the second that of business value; the third that of variety. The first suggestion is one of the greatest importance in the eyes of many merchants. But this is where they all err, for the very simple reason that cost for cost, the electric sign has proven itself to be the cheapest form of advertising extant. By this is meant that a hundred dollars worth of light in the form of an attractive looking sign is by far a more effective means of exciting comment and causing a sensation than five times that amount in printed matter or poster form. The business value of the electric sign is hardly within the line of discussion, because of the fact that its merit is fully understood on all occasions. In fact, it is quite evident, that the subtraction of the electric sign from New York City would be one of the worst blows certain lines of business could experience. It might be mentioned in connection with their cost, that false ideas prevail in the public mind on this score alone to such an extent that some are doubtful to the last of the financial outset, in spite of assurance backed up by those of the highest responsibility in the lighting field.

A few hundred dollars a night, has been the estimate given to a leading New York newspaper, for the cost of electric signs along Broadway, where it is most brilliantly lighted. When the lavish expenditure of money is considered, which goes for postage, circular letters, advertising in newspapers and street car advertisements in many forms of business, the electric sign stands apart, singularly free from cost in comparison.

The two references to cost and business value are therefore easily covered by the foregoing suggestions, touching upon those points in connection with electric signs. There now remains the necessity of considering the idea of variety in this respect, or to be still more explicit, the degree of novelty the sign presents while in use. Everything becomes commonplace, as we become more and more accustomed to it, and in this respect the electric sign is not exempt. Therefore, the idea of novelty in connection with electric signs, is also one of cost, because of the changes that must be made in its design at intervals to preserve its newness and therefore its advertising value.

The comparative cheapness of electric signs is thus more than a theoretical proposition in actual cash expenditure. One side of the problem that could be brought forward, would be made evident by the question applying to any specific case as follows: "To what extent would sales be affected by the reduction of advertising in the way of electric signs?" One of the largest manufacturers in this country tried that experiment and in the result of it is found the answer to the question presented. They found in the course of a year a considerable reduction in sales, that could not be traced to either a change in the quality of the goods, or to a change in the general advertising methods employed. The only solution to the problem, which otherwise seemed unsolvable, was the electric sign. Its continuance on broader lines was the means in the succeeding year of reestablishing their business to a greater extent than before. From this standpoint, electric signs have a great influence in causing sales at an expense that is comparatively low.

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An Improvement in Wiring

The risks of fire and injury to wires have been receiving attention from many engineers interested in the development of safe electric wiring. The use of molding, iron pipe and insulators for the protection of current carrying wires, has at times been subjected to the criticism that, although safe, they represent only a form of protection that is not part of the wire itself. It has been suggested by some English specialists that great improvements would result if wires were lead-encased and made into twin conductors. The suggestion was based upon the idea that a pair of lead-covered wires could be readily installed. Where they are to be buried in plaster they could be quickly attached to the wooden joists generally found in walls or to the mortar foundation otherwise present. The burying of them in plaster could not affect their strength of position nor increase the fire risk to any marked extent.

Such are the arguments advanced in favor of twin conductor lead-covered wires by our English friends, and it must be admitted that they are sound enough. But it is hardly necessary to remind them of the difference between our skyscrapers and their low office buildings. Feeders or risers supplying the upper floors and in fact all floors, would occupy so great a space that the mere "burying in plaster" idea would not do. Pipe ducts are very convenient additions, not only because pipes are used, but for the better reason that in this manner all conductors are accessible. The question that arises is whether it will pay to bury conductors, even such as are used in rooms, permanently in plaster.

A Few Statements

It might be asked "How can the introduction of the steam turbine affect the central station so markedly?" Or in what respect are such advantages gained that the substitution of one type of steam consuming apparatus for another is to be hailed with approbation? Only a purely commercial reply can be made to this inquiry. It is decidedly cheaper to install and employ turbines than engines. The lowering of the expense is found in the more limited rate of depreciation; in the greater economy of operation and in the reduced consumption of oil. The greater ease of coupling is not as great or as important an item as the reduction in floor area.

It is far better to produce continuous rotation by steam or any other power if possible than a series of disconnected and reversing impulses. As there is in this, as in the generator, only rotation to consider, it is not susceptible to the same wear and tear as a mass of linked mechanism needing constant attention and careful lubrication. This, therefore is the point of greatest interest—the saving in labor for care and attention. About one million horse-power in turbines now in use, is a testimonial at least, to the advance made in that field on a basis that makes a strong appeal to central station managers.

CURRENT IDEAS

For Furnishing More Light, Heat and Power from Central Stations

How to Get the Old Buildings Wired

By F. H. Golding.

Great possibilities for remunerative business in lighting are offered by the residences, and central station men generally are awakening to the fact that a strenuous effort should be made to secure this class of business, particularly the old houses in which gas or some other established illuminant offers strong competition.

The campaign outlined in this paper has produced most gratifying results and is adapted to the needs of the average central station, subject, possibly, to minor changes or modifications made necessary by local conditions. To attain the highest efficiency, this campaign should be supplemented by a liberal policy as to the kilowatts connected for which service will be furnished. One central station that has been very successful in securing old house business by these methods—in fact, increased 700 per cent in 18 months—will give service to any installation, no

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matter how small the current consumption promises to be, on the assumption that the use of electricity even in the most trivial manner soon becomes a habit and inevitably leads to a more extended use.

As a preliminary, a house-to-house canvass of the residential districts should be made, the information thus obtained to be compiled in card-index form, containing the street and number of each house, name of owner, name of tenant or tenants, means of illumination in use and if electricity is not used, whether or not the house is wired. With this information available the solicitor is in a position to work his district intelligently and systematically, canvassing a block at a time and persisting until he has had one or more interviews with the head of every family in his district. After the preliminary canvass he may select those offering the most favorable prospects and concentrate his efforts on these selections, endeavoring to have not less than one or two on each block in his territory.

The head of the new business department, being informed by daily reports as to the progress the solicitor is making, should aid him with mailings of personal letters and literature pertaining to various lighting and power appliances for the home use.

If the solicitor is at first unsuccessful in interesting the prospective subscriber to the extent of lighting his entire premises with electricity, he should endeavor to secure an entering wedge in the shape of a cellar or porch light, an electric iron, sewing-machine motor, or any other appliance that he thinks will most appeal to his prospect, offering the free use of same for a 30 or 60-day trial, provided the prospective customer will pay for the small amount of wiring necessary and for the current consumed.

It is right here that a liberal policy on the part of the company is of vital assistance to the solicitor. as the appliance most favored may be a heating pad, night light, or something else in which the current consumption is negligible. Having obtained a foothold, it is comparatively easy for a capable solicitor to gradually extend the uses of electricity in a home by a diplomatic and unobtrusive introduction of other appliances so that almost before the householder realizes it he is relying on electricity for his light and various other needs and wondering how he could have gone without it so long. The enthusiastic testimonial of the pleased subscriber thus obtained is of material assistance to the solicitor in his work in neighboring houses, hence the importance of obtaining at least one on each block.

In conjunction with the solicitor's work, a good series of newspaper advertisements should be used, care being taken to have the copy attractive and readable and arranged to fit the season or local conditions. For instance, in the fall, when lengthening and chilly nights offer the opportunity, devote the article to porch lights or electric radiators; in the winter, when the furnace must be cared for, to cellar lights; in the holiday season, to attractive gifts, such as chafing dishes and coffee percolators; in the spring, to flat-irons, fans and other electrical hot weather comforts; in epidemics of sickness, to heating pads, sterilizers, turn-down lamps, and so forth. In addition to the work above outlined, very good results can be obtained from a special advertisement inserted in the "For Sale or For Rent" columns at intervals, advising the prospective purchaser or lessee to consider the desirability of electricity and avoid houses without it. These should be brief and pointed, and alternated with appeals to the real estate dealers to wire all their houses and thus secure higher prices and easier sales. Pamphlets, flyers and other mail matter, seasonably selected and pertaining to local uses or events when possible, should be freely used. The accompanying illustration of a "Burglar" pamphlet, issued at a time when several burglaries had occurred in succession and the city was much aroused in consequence, is a good example of what this class of matter could be, and was directly instrumental in securing many customers.

A liberal use of small electric signs, scattered freely through the residential sections, and of illuminated billboards is a valuable adjunct to residential work. The signs should be of the picture-frame variety, to facilitate handling, and should be changed to new locations twice or three times a year.

Arrangements can be made with store or shopkeepers, by making a concession in their lighting rates, for the location of signs on their buildings and the switching on and off—the company's trouble men, or sign men if it has them, caring for the renewals.

The billboards should be erected in favorable positions, preferably along the routes of the street-car lines radiating out into the residential districts, and should be repainted at least two or three times a year to retain the interest of the passing public.

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Trough reflectors may be used for the illumination, and the reading matter and illustrations should bear on the uses of electricity in the home. A time switch may be used to control the lighting, unless the central station maintains a sign-switching service.

The company should be prepared, where conditions seem to warrant and the prospective customer's responsibility is assured, to offer a proposition whereby the installation of wires and fixtures may be paid for in instalments—weekly, monthly, or quarterly, as may be desirable. By this means many customers can be secured who would not otherwise feel able to meet the installation expense. If the central station does not do interior work, a satisfactory arrangement could be made with the electrical contractors whereby the latter would add, say, 10 per cent for interest and the expense of carrying the account, the lighting company guaranteeing the contractor against loss. As the cost of the average installation will not exceed $100, the percentage added will lay no great burden on the customer.

A number of central stations about the country have in effect a plan whereby a certain number of outlets is installed at or below cost, and some of them are obtaining very satisfactory results, but propositions of this character must be governed entirely by conditions existing in the territory served and should be carefully considered. In one city recently brought to the writer's attention, where the lighting company installed the first work with its own men, the practice was discontinued because the contractors regarded it as a usurpation of their prerogatives, and when called upon to furnish estimates for wiring the remainder of a house would add to the estimate a sum equivalent to the assumed profit they would have received on the original work. In another city, where the lighting company arranges with the electrical contractors to do the work and pays them the difference between the amount the customer pays and the normal price for the installation, the plan has worked out well.

The question of getting new houses wired is so closely allied with the one under discussion that a few words on the subject may not be amiss here.

In growing cities it is advisable to maintain solicitors exclusively for this business, averaging one man to about 50,000 to 100,000 population, depending on how rapidly the city is growing and new houses are being erected. It should be the duty of the "new-house man" to keep track of the building permits and of the building trades notes, to keep in close touch with architects, builders and real estate men, and a generally watchful eye on new buildings. In the latter he will be aided by the daily reports of the district solicitors, who should be required to note on their reports the building preparations in their districts.

He should receive the same assistance in the form of follow-up letters and other mail matter that the other solicitors receive, and, in addition to that, a special mailing series to architects, builders and real estate dealers should be used. The special series, supplemented by frequent personal letters proffering the services of the company's illuminating and construction engineers in laying out the supervising and installation of distributing systems free of cost to the persons addressed, could consist of mailing folders containing illustrations of successful residential lighting effects, preferably local, and reading matter descriptive of and calling attention to the illumination in the picture. One lighting company in a city of about 100,000 population adopted a similar plan for its new house work with the result that, while less than 10 per cent of the new houses built in the city during the first five months of 1905 were wired, during the same period in the current year 92 per cent. were wired.

How to Get New Buildings Wired

By J. S. Cartwright.

This is a subject that seems, upon mere cursory consideration, to be of small account and not worthy of more than a passing thought, as compared to the many momentous questions which confront an association of this kind, with its great diversity of practical and theoretical interests.

It seems almost a sacrifice of our time and energy to question for a moment that in any community with modern ideas and practices on this hustling globe of ours, with the seemingly inexhaustible developments that are being made in electrical science and appliances, that there could exist a man, body of men, company or corporation that would erect any kind of a building, for any purpose whatsoever, except a dungeon or perhaps a gasometer, unless it were wired for the use of electricity and the various appurtenances connected therewith.

Well, you say there are just such in existence, and how, then, can we overcome the various objections that are raised against the consummation of

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what is really the bed-rock foundation of this association and its desires.

You think this is a little too strong, do you? but is it? If new buildings were not wired, we should then be obliged to depend upon our municipal lighting or buy up a railroad and generate our current to run it, and surely if new buildings were not wired people could not see the multitudinous advantages of electricity, consequently there would be little desire to wire old buildings; one being contingent upon the other, we should thus have a limited field for action.

There are really many more phases to this question than appear upon glancing at the title of this paper, among which are the cost questions of desirability and necessity, risk of fire, danger to life, and, many times, the perverseness and stubbornness of human nature to awaken to the fact that the world "do move," and that new buildings, both large and small, must embody the latest features of modern engineering in this ear of triumphal progress to make them attractive to the people for whom they are constructed, and by whom they are to be occupied.

Let us first consider the cost. This is given precedence in the list of objections, as it certainly stands pre-eminent and is one of the hardest to overcome; it is the basis of all interest, tax, rental and depreciation charges. With iron and terra-cotta construction, of which nearly all the large buildings are composed, I believe the cost after being presented as a total, should be analyzed on a relative percentage basis—that is, per outlet, per light, per square foot of office and corridor space, and so forth, so as to be able to talk in small figures while keeping in mind the many advantages for your reserve force; before making use of the latter you will have other places upon which you can concentrate your energy. They are: first, the architect, and next, the builder.

As a general rule the majority of building syndicates, as well as individual owners, place implicit confidence in some one firm of architects and give careful consideration to any recommendations that the architect may make to them. Outside of the pecuniary gain that results to both the architect and builder on account of the increased cost, the architect occupies the same relative position to the owner as a lawyer does to his client. To the architect, then, your central station solicitor should turn and continue his endeavors and make his arguments as to the advantages of having the proposed building wired. He should offer to assist in the layout of the lights, outlets, and so forth, so that the most advantageous conditions can be realized; he should supply the architect with all necessary data and literature of the various electrical appliances, labor-saving, heating and cooking, signs, motors and general illuminating in its various forms—in fact, everything up to date that he can conceive of or suggest—and should keep up a persistent, but not obnoxious, hammering until he has gained his point. If possible he should arrange a meeting with the architect and owner together; and there is one thing that he should always remember, and that is, that those to whom he is talking and whom trying to convince are not supposedly technical on electrical matters, so instead of talking about volts, amperes, kilowatts, and similar terms, he must remember to talk plain, everyday dollars and cents. I mention the builder in passing, but do not consider him of prime importance on this preliminary solicitation, though I believe he is often of sufficient weight to keep in touch with, as he is frequently called into consultation with the owner and architect on many details of construction. He is constantly erecting all kinds of buildings, both large and small, and, like the wiring contractor, comes in contact with people of all shades of opinion, and I think, as a general rule, is more in touch with the public pulse and so realize more of the general requirements of the people at large than many of the architects, and can surely be made use of in presenting our final arugments.

There is still one other your solicitor can make use of, and that is the wiring contractor. There should exist an *esprit de corps* between the central station company and the wiring contractor, as there exists oftentimes among the general public a feeling that the solicitor representing a lighting monopoly is actuated entirely by selfish motives, and people are therefore more inclined to turn down his arguments than those coming from a less interested party. The wiring contractor, while having an interest in the wiring, does not derive any income from the use of it after the current is turned on, and, consequently, cannot be accused of having an entirely selfish interest in having the building wired.

As to the risk of fire, I think, as a rule, there need be little real objection to having a building wired where the work is done by a reliable concern, with first-class, well-paid and conscientious work-

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men, under the stringent rules of the insurance companies, and oftentimes the municipality, together with constant and eagle-eyed inspection under these rules as the work progresses. These conditions ought to present to the most abstruse and conservative owner the strongest arguments that could be offered against any objection he may make on account of risk or fire.

As to the danger to life, there are probably many who have a natural timidity for nearly everything they do not understand or cannot see, outside of the ordinary humdrum affairs of everyday life. Of course, to combat these objections we have statistics to prove that there is very little loss of life from electricity, and furthermore, I believe that but little argument will be necessary to prove that there is no one commodity so universally used under all kinds of conditions that has caused so few bad accidents as the electric current.

In this particular line I believe but little time should be wasted in argument. The old saying "seeing is believing" is as true to-day as it was years ago, and it is only necessary to get your prospective customer to your well-equipped showroom and there demonstrate plainly what you have been saying verbally. I believe that a little time spent in this manner generally accomplishes more than many hours spent in talking.

Your solicitor, if he has not up to this time wholly accomplished his purpose, can then call in the specialists. This is your reserve force, and by these I mean the elevator companies, the companies with the various electrical office devices, the fixture company, the heating, cooking and ventilating devices; after all these have had their say and presented their arguments, the prospective owner is probably ready to succumb to any proposition that will get his building wired and restore him to his normal condition.

While these general ideas apply to the larger buildings, on a different scale they also apply to the smaller buildings, by which I mean the houses which are built for their owners' occupancy or the houses that are built to rent or to sell. I believe in furthering the wiring of this latter class of building and that a well-posted lady solicitor can accomplish in a great many instances more than a man. It would be advantageous for the larger lighting companies to have at least one lady on its corps of solicitors—one who is not only a good talker and demonstrator, but who has had practical everyday experience with the sewing-machine motor, the electric flat-iron, the heating pad and the various electrical heating and cooking utensils; one who has used and thoroughly understands the handling of these various devices, who can talk intelligently to the housewife and create the desire for their use —then you know the result; the new house has certainly got to be wired, and no further argument is necessary.

If a family has once had the conveniences and comforts of an electric installation, it is very rare that it will move into a building in which one is obliged to hunt around for a match every time a light is wanted, and will not put up with the trouble dirt, heat and smoke of any other form of service, and, as for buying a building or home that is not wired, they will stand for almost any other omission without fault-finding, but not the lack of wiring.

There is one more objection of which I made mention, and that is personal characteristics—although I called it by a different name previously. Some people are hard to convince—they refuse to be convinced—and that certainly makes it a hard proposition for the solicitor. He must talk of the desirability and necessity, the many advantages, the enhancing of values, the greatly-increased cost after completion, but must not seem over-desirous of selling the current after it is wired. Keep that in the background, but keep it in mind; be quick-witted but not quick-tempered; expect and receive abuse but do not give it; forget it and be a diplomat, but constantly keep pictured in your mind that building being erected, all those wires going into it and the current coming from your station and going onto those wires—do not forget that.

There is one more phase of this question that I have not taken up here, but of which I will make slight mention before closing, and that is advertising. The various visits of your solicitor should be interspersed with some judicious advertising matter. By this I do not mean large bulletins with art-gallery covers and miscellaneous contents, but more in the small pamphlet form, with short, pithy arguments covering the particular result you are trying to accomplish. Remember that what is worth accomplishing is worth going after, and that good, intelligent, personal solicitation has caused more new buildings to be wired than all the printer's ink ever made. The age of generalities has gone and we are now in an age of specialties, and while versatility is a good thing at the dinner table or at some social

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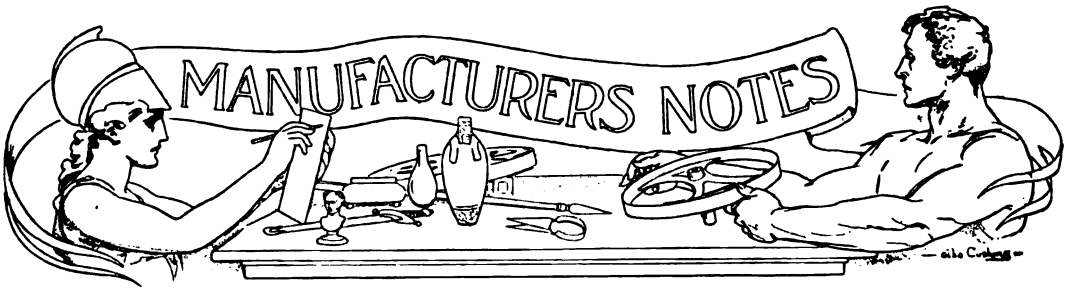
tea, it is the man in business who specializes that draws the largest salary; for that reason the solicitor seeking to get new buildings wired, who has the greatest success in this line, has got to school himself to be a specialist in this branch of electrical work.—*Presented at N. E. L. A. Convention.*



The recent cry of "dull times," raised by various manufacturing interests of the country, finds no echo in the business of Allis-Chalmers Company which continues to show a steady gain. During the month of May this company shipped from its works 553 cars of machinery, which was a gain of twenty cars over the record established for April. In April the aggregate weight of shipments was 21,680,847 pounds, while for the month of May the figure had risen to 23,772,242 pounds, making a total by weight for the two months of 45,463,089 pounds. Cars bearing this enormous quantity of machinery, if coupled in one train, would have covered a distance of about eight miles.

The Northern Engineering Works, crane builders, Detroit, Mich., report recent shipments of cranes for power station service: a 24-ton capacity x 62′ span, for the Buffalo & Susquehanna Coal Mining Co., at Sagamore, Pa.; a 6-ton capacity x 36′ span for Winchester and Washington City Ry.; and a 5-ton x 36′ span for Watertown Electric Light Company.

The Holophane Company (Sales Dept.), 227 Fulton street, New York City, have just opened a branch office at 157 Minna street, San Francisco, California, under the management of Mr. F. H. Poss, who is well known to the trade on the Pacific Coast. They intend to carry a large line of globes and reflectors at this office which will enable them to make prompt deliveries; this being in keeping with the well-known policy of the Holophane Company. Only standard packages will be sold.

The General Electric Company desires to announce that it is ready to supply Tungsten lamps for series street lighting service.

The application of incandescent lamps to street lighting service should be widely extended by reason of the advantages, tungsten lamps possess for this class of service. They can be supplied in low candle-power sizes permitting distribution of lamps at frequent intervals and thereby securing maximum economy with uniform and satisfactory lighting.

The high efficiency now obtained by the Tungsten lamp will enable central station companies to compete successfully against any other form of street illuminant of low or moderate candle-power.

Tungsten lamps are particularly adapted to series lighting service as the lamps are employed in low voltages which permit the use of short, stable and durable filaments.

G. E. Tungsten lamps will be supplied in 40 and 60 c.p. in the following ampere ranges, 4.—5.5—6.6 and 7.5 amperes. Forty candle-power is considered the minimum desirable candle-power for this class of illumination. Present 3.5 ampere systems can increase their current to 3.8 and 3.9 and thus come within the 4. ampere range. Further data and prices are given in Bulletin 4,504, which will be sent on application.

The Murray Iron Works Co., of Burlington, Ia., report these recent sales:

One 20″ x 36″ Murray-Corliss engine for direct connection to Crocker-Wheeler generator, Peoria Stone & Marble Co., Peoria, Ill.

One 12″ x 30″

One 14″ x 36″ Murray-Corliss engine for direct connection to Western generators for the Thompson Hotel Company, Lincoln, Neb.

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One 12" x 36" Murray-Corliss engine for belt connection to a generator, Marengo (Iowa) Electric Light & Power Co.

One 20" x 42" Murray-Corliss engine for belt connection to a generator, Trenton (Mo.) Electric Light & Power Co.

One 24" x 36" Murray-Corliss engine for direct connection to a generator, Municipal Light Plant, Newton, Iowa.

One 14" x 28" x 42" tandem compound Murray-Corliss engine for the Fairbury (Neb.) Electric Light & Power Co.

One 12" x 36" Murray-Corliss engine for direct connection to Western generator, South Carolina State Hospital.

One 16" x 36"

Three 20" x 36" Murray-Corliss engines for direct connection to Westinghouse generators, The Iowa State Board of Control for various public institutions.

White Star Continuous Oiling Systems, which mechanically keep engine bearings supplied with a steady stream of pure lubricating oil, have recently been installed by the Pittsburg Gage & Supply Co., Pittsburg, Pa., in the power plants of the following concerns:

Windsor, Essex & L. S. Rapid Ry. Co., Kingsville, Ont.

Buick Motor Co., Flint, Mich.

Warwick Mills, Centerville, R. I.

Fitchburg Yarn Co., Fitchburg, Mass.

Kaufman Bros., Cincinnati, O.

Washington Electric L. & P. Co., Washington, Pa.

Federal Furnace Co., Chicago, Ill.

American Wood Working Machine Co., Rochester, N. Y.

Utica Knitting Co., Utica, N. Y.

Harrisburg Light, Heat & Power Co., Harrisburg, Pa.

Baldwin Locomotive Works, Philadelphia, Pa.

Ames Iron Works, Philadelphia, Pa.

R. A. Long Building, Kansas City Mo.

Reo Motor Car Co., Lansing, Mich.

Electricians, linemen and others have often asked for a convenient solder flux in such form as to be clean to handle and at the same time efficient. The Chase-Shawmut Co., of Newburyport, Mass., now have something that will appeal to everyone, whether at work soldering on the top of a pole or mending a tin pan in the home. The Red "E" Solder Paste, although new to the public, has been used and tested for a number of years by individuals and found in every way satisfactory. For work where only a little paste is needed, such as line, laboratory or shop work, there is nothing as clean or convenient.

It is put up in collapsible tubes so that there is absolutely no waste, and can be carried in the pocket or tool bag with perfect cleanliness.

Red "E" Solder Paste is non-corrosive and does not act like an acid, but cleans the surface, and acting as a flux makes the solder run freely. Temperature, weather or material makes very little difference. It will keep indefinitely and is "Red E" at any time and in any place.

It is put up in two sizes of tubes, one ½" x 4" and the other 1" x 6" long.

Retail prices, small tube 10c, large tube 25c.

Flaming Arcs Lamps at the New York Post Office

The six Excello flaming arcs recently erected at the North mailing platform of the U. S. Post Office, Park Row, have created considerable attention, being an installation very demonstrative of the great luminosity and efficiency of Excello flaming arcs.

It was found that the former illuminants, consisting of an aggregate of ten ordinary enclosed arcs, and some eighty twenty incandescent clusters were insufficient for the handling of the enormous mailing business transacted there. To get three times the light with, at the same time a reduction of load, was the problem the Post Office authorities were confronted with. The merits of the Excello flaming arcs were carefully gone into and as a result, an installation of six 10 ampere Excello flaming arcs was decided upon.

The partial tests proved that these six lamps not only gave all the light requisite, but that the current consumption of the platform illuminants was reduced fully 60%. We understand that not only the heads of the United States Treasury, engineering departments, but also the platform operators are very much pleased with the results.

Particulars about the lamp used in this installation may be obtained from the Excello Arc Lamp Co., 24-26 East 21st street.

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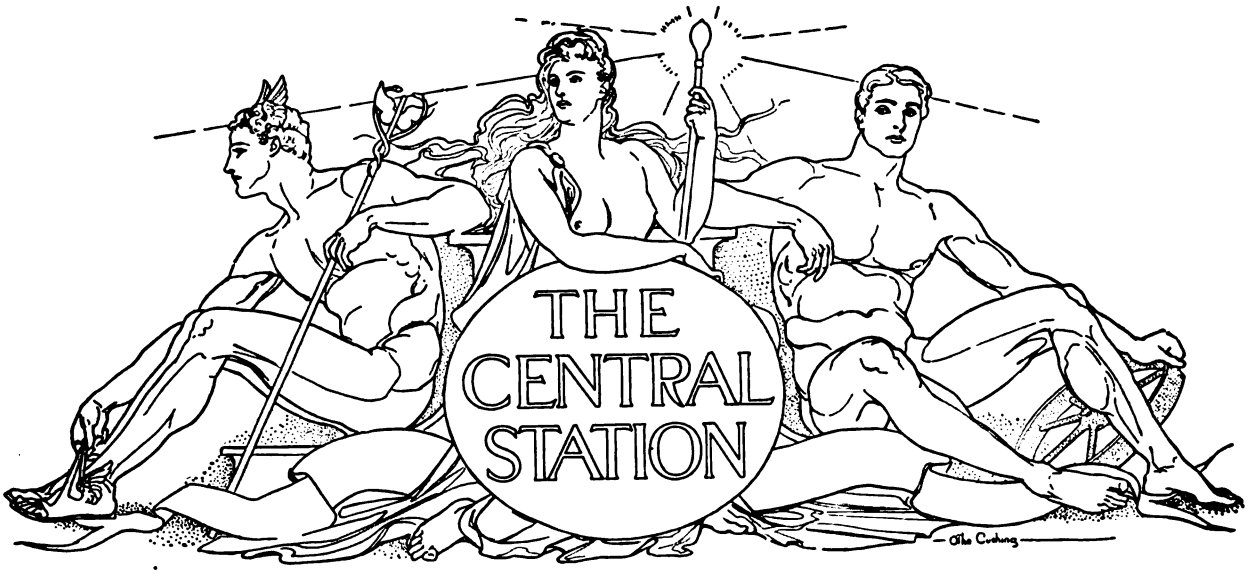

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

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Central Station Light, Heat and Power Principles

BY NEWTON HARRISON.

Switchboard Instruments.—The types of instruments employed on switchboards in large central stations are being improved and developed to cover many departments of the work. In the direct current and alternating current fields there is naturally a difference, though not in the so-called essential instruments in use.

Direct Current Instruments.

1. Ammeters.
2. Voltmeters.
3. Wattmeters.

The alternating current switchboards may carry the following instruments:

Alternating Current Instruments.

1. Ammeters.
2. Voltmeters.
3. Wattmeters.
4. Synchroscopes.
5. Frequency meters.
6. Power Factor meters.

The difference to be noted thus far is that the essential instruments are alike such as the ammeters, voltmeters and wattmeters; the actual alternating meters being those used exclusively for that class of work and useless for direct current, both in principle and intention. In addition to these instruments others are employed that may be noted as follows:

Additional Switchboard Devices.

1. Current Breakers.
2. Ground Detectors.
3. Lightning Arresters.
4. Bus Bars.
5. Rheostats.

The class of machinery to which these devices are applied is all within the scope of the central station and power transmission plant. The division then occurring is only that naturally due to the classification of the three phases with respect to the particular instruments they embrace. For instance, under the head of wattmeters may be found:

Wattmeters.

1. Single Phase.
2. Two Phase.
3. Three Phase.

The latter two, namely the two and three phase

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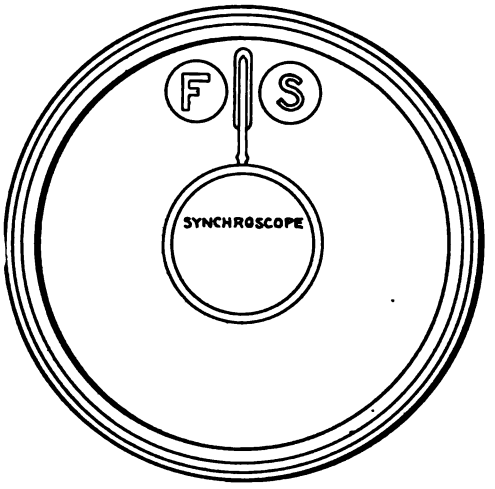
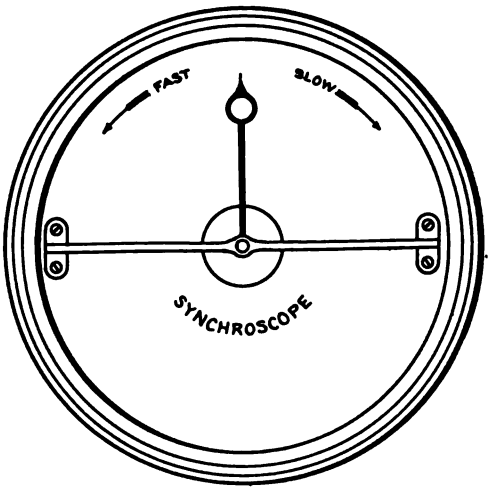
wattmeters are not only constructed to be used for various alternations, but are similar in appearance to the single phase meters. Series transformers



SYNCHROSCOPE.

are employed in the three cases for power measurements, unless the amount is small and the instrument necessarily limited in caacity. In this case, with a maximum of 5 amperes and 400 volts no series transformer is necessary.

For higher pressures and different frequencies the style of transformer is shunt instead of series, unless special shunts are otherwise employed.



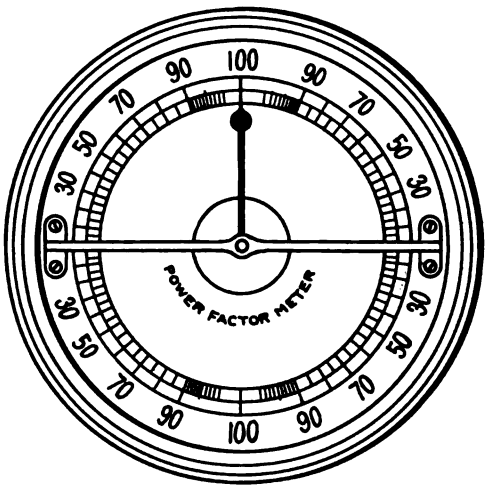
SYNCHROSCOPE.

The Synchroscope.—This instrument is one which displaces the lamps formerly used to indicate the fact that two machines were in step. It is unique as a type of synchronizing apparatus for the reason that it performs the following service as well:

1st. Whether the alternator is too fast or too slow.

2nd. The degree to which it is out of step.

By its means heavy rushes of current are avoided and time is saved during the synchronizing of two machines. The power factor meter and the synchroscope are very much alike in construction. A pointer is made to revolve "at a rate equal to the difference in speeds of the machines in question," and by the side to which it deflects, and the motion it assumes indicates whether the newly thrown in alternator is too fast or too slow. When the two machines are of equal speed the pointer will show the difference of phase existing between them, and



POWER FACTOR METER.

when this is overcome the needle will coincide with the figure of a pointer on the dial.

The Frequency Meter.—By means of this instrument the frequency of the current is immediately noted, thus saving the need of calculation of the cycles from the speed and number of poles. In the latest types of approved pattern changes of voltage do not affect the registration of the frequency, though when a higher voltage than 100 is tested a shunt transformer must be employed. Where frequency changers are employed to modify the line frequency for any particular purpose in whole or in part, this instrument is very serviceable. As a general rule the frequency meter is calibrated to measure ranges of pressure vary from 20 to 30 cycles per second: to 40 to 75 cycles per second.

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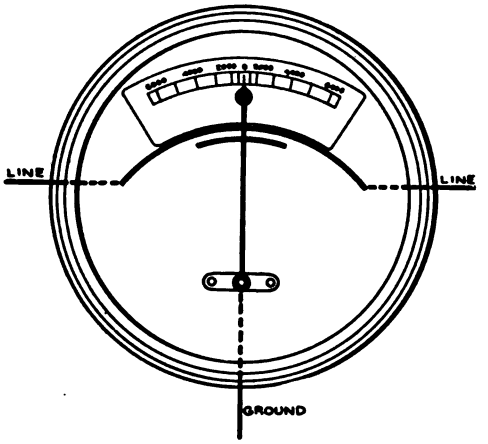
The Power Factor Meter.—The wattmeter is necessary for the measurement of real power. By means of the power factor meter the reason why an ordinary computation of power by multiplying volts by amperes, is false, is made evident in alternating current work when the line is affected by or exposed to either self-induction or static capacity. Real power in alternating current circuits is equal to the apparent power multiplied by the power factor. The power factor is obtained by dividing the true watts by the apparent watts. In other words, the values obtained, by dividing a wattmeter indication by the product of a corresponding volt and ammeter indication are those that appear on the dial of the power factor meter when in service.

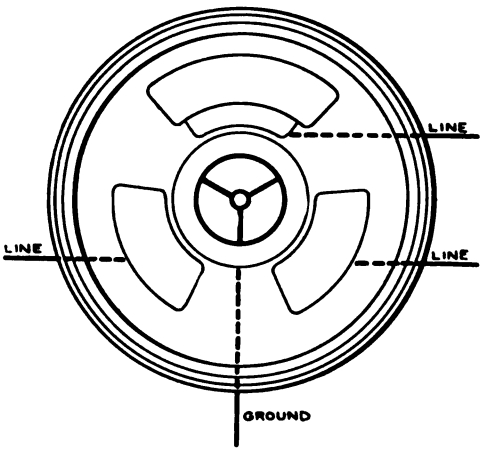


STATIC GROUND DETECTOR.

The presence of induction in the line, due to what is commonly called an inductive load is indicated, and in consequence means may be taken to so modify the line current by field adjustments that the evil effects of this are greatly reduced. In cases where rotary converters are employed the power factor meter will prove of great service in a similar manner when the power factor is bad.

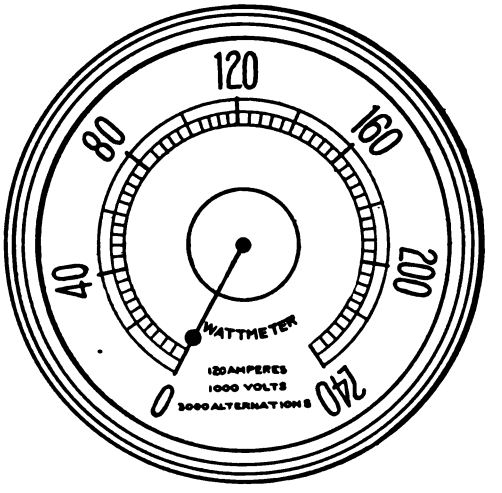
Static Ground Detectors.—The ease with which serious trouble is avoided on main lines by the use of ground detectors is illustrative of the theory that a stitch in time saves nine. Static ground detectors contain two fixed plates connected through condensers and to the lines. A third movable plate delicately suspended connects by line to the earth and is well grounded. When a leg of the line is grounded the movable plate is repelled away from the plate to which the affected line is connected.

In order to facilitate the readings from afar, the meters in many instances are built with a lamp hidden away inside, but convenient enough to get at, and by this means supplying such light to the scale



THREE-PHASE STATIC GROUND DETECTOR.

as will show its figures plainly. The need of this system of readily getting the figures recorded by the pointers of the various instruments was felt for a long time, and led to the invention of a few useless devices to overcome this difficulty. Voltage indicators and pilot lamps were among the means adopted to hold the pressure fairly constant. Modern meters have dismissed them, particularly since



WATTMETER FOR POLYPHASE CIRCUITS.

they are built for easy reading by means of illuminated dials.

Measurement of Resistance.—One of the most familiar of all tests is that carried on for the purpose

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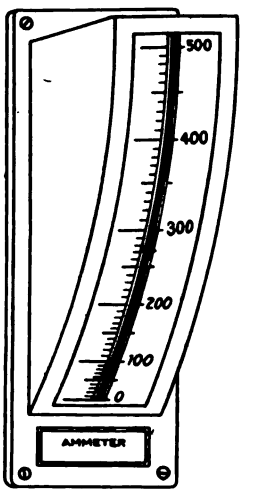
of ascertaining the resistance of a conductor. Though it would seem as though this included the general scope of all tests of this character, yet other tests of equal importance, in an engineering sense, must be made of the very opposite of good conductors, namely, insulators. Thus, tests of resistance might be generally classified as measurements of very low resistances, very high resistances and of resistances which occupy a middle place between these two. To illustrate—resistances of .01 of an ohm, of 1000 ohms, and of 1,000,000 ohms, represent a good difference in value. To make sufficiently accurate tests of these, to gain satisfactory results, methods must be employed which belong to the general category of resistance measurements. A few of these tests can be considered under the heads of, first: Drop of Potential Method; second: Method of Substitution, and third: The Wheatstone Bridge Method.

Drop of Potential Method.—There is no reason to believe that a simpler method than this can be presented in developing the idea of resistance measurements. It is based upon the proposition contained in one form of Ohm's law that the pressure which is necessary in a circuit to send a given current through a given resistance, is equal to the product of this current by the resistance. In other words, if the proposition is given—find the resistance of a circuit whose lost pressure or "drop" equals 100 volts when carrying a current of 10 amperes, the answer can be readily given on the above basis. A loss of 100 volts, or whatever it may be, is caused by a certain current passing through a definite resistance. This resistance degrades the electrical energy by destroying its potential, to an extent dependent upon the current entering it and its own influence as a conductor. A loss of 100 volts means a degradation of electrical energy equal to $100 \times 10 = 1000$ watts, the amperes being 10. But a waste of power like this is caused by a resistance of 10 ohms. The energy degraded appears in another form as heat and is equal to the product of $10 \times 10 \times 10 = 1000$, or the square of the current multiplied by the resistance.

With an alternating current, the waste of energy is the same, provided the square root of the mean square of the current equals the 10 amperes, and the resistance is the same as given. The $C \times R = E$ and R is obtained by dividing E by C to get R. As $E = 100$, its division by $C = 10$ to get $R = 10$ is obvious.

Method of Substitution.—Measuring resistance by the method of substitution is really a comparative method. If a certain known resistance will cause an indicating instrument to show a deflection of 100 divisions and then, when another resistance is put in its place the deflection falls to one-half or 50 divisions, it is evident that the resistance must be twice as great. The reason for this is found in the reduced deflection. This means less current or more resistance. If the conditions are otherwise the same, the drop in the reading of the indicating instrument to one-half proves the presence of twice the resistance. Ohm's law, as statd, that the current



ILLUMINATED DIAL AMMETER.

is directly proportional to the electromotive force, and inversely proportional to the resistance means, when applied to this case, that if the electromotive force has not changed, but the current is one-half as shown by the deflection, the resistance is twice as great.

The bridge method is one established as an absolute means of determining the true value of the resistance by the comparison of two pairs of resistances arranged in a double mesh; *i. e.*, two isosceles triangles placed base to base. Where the two bases coincide the galvanometer is placed, where the four sides are found resistances are inserted. The ratio between the arms is generally considered as the ratio of A to B and C to D. These ratios must be equal to each other when the galvanometer balances. If A, B and C are known, it is quite evident that D will be readily ascertained if the resistance is to be found by carrying out the indicated operation.

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Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Duty of the Electrical Company to Insulate—Location of Wires and Converter

The opinion of the court contains the essential facts and is in part as follows:

"In view of instruction No. 7 given by the court, it is important with particularity to state that part of the complaint charging the negligence of the defendant and the antecedent matters of description or inducement. After allegations that defendant corporation was maintaining and operating an electric light plant in the City of Denver for conveying and supplying electric light to dwelling houses and other buildings therein, and that it had connected its wires with the dwelling house of plaintiff's father, with whom plaintiff, a minor twelve years of age, was then living, and that such connection was for the purpose of supplying light to the house, and defendant had attached to the house, directly under one of the windows, an electrical device called a 'converter,' and had set and placed certain iron supports to receive and hold glass insulators upon which were attached wires conecting with the house and conveying thereto the electric current for furnishing light, the complaint proceeds to charge that, whereas, it was the duty of defendant to cause the wires to be sufficiently and securely covered and insulated, and at all times so to keep and maintain them, the defendant, on the contrary, so negligently managed and conducted the wires that the covering thereon became weak and broken and out of repair, so that the wires were not covered or insulated, the result of which was that the current of electricity borne thereupon would and did pass therefrom; that on the day in question the plaintiff, who was an inmate of his father's house, while looking out of the window of the bathroom and seeing that one of the glass insulators had by some means fallen, or been removed, from the iron support where it was wont to rest, and not knowing the dangerous condition of the wire, or that any electric current could or might pass therefrom, and not realizing that the attempt to replace the insulator was attended with any danger to him, seized hold of the insulator in order to place it upon the iron support, and to the wire which was so attached, being naked and bare near to the insulator, the covering thereof being broken, plaintiff's hands and fingers were drawn by the electric current borne by the naked wire, or accidentally and without plaintiff's fault placed thereon by him, and 'thereby, and solely by means of the negligence and want of due skill and care of the defendant in and about maintaining and caring for the said wire and preserving the same insulated and safe as aforesaid, the electrical current borne upon the said wire passed to and into the hand and body of plaintiff, and by the force thereof,' etc., the injuries were sustained.

"The seventh instruction is as follows 'It is the duty of every corporation which undertakes to supply the electric current to a dwelling to exercise a high degree of care in order to prevent injury to those inhabiting the dwelling, and particularly children by coming in contact with their wires and other appliances and such care must be exercised both in protecting such wires and appliances against contact, and in the selection of the locality where the same are placed, and if the defendant company failed to exercise the degree of care and diligence in either respect, and by reason thereof the plaintiffs, or either of them, received injury without fault on their part, the defendant is liable.'

"The paragraph, in effect, told the jury that plaintiff's cause of action was grounded upon two acts of negligence—one in selecting an improper place on the wall of the house for placing its wires and converter; the other in failing properly to keep them safe after they were placed there—and that if the

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defendant failed in either respect to exercise the proper degree of diligence, it was liable if injury thereby was caused plaintiff without fault on his part. This instruction is fundamentally wrong, and the error in giving it is accentuated since, in its third instruction, the court had fully defined what defendant's duty was, concerning the only charge of negligence specified, in maintaining its accessible wires. When at the trial plaintiff offered evidence concerning the location of the wires and electrical appliances, the defendant objected to the same upon the ground that the charge of negligence in the complaint was not in their location, but only in neglect in the maintenance of wires. The trial court, however, overruled the objection because, as the transcript shows, according to its notion, the Court of Appeals had ruled such evidence of location admissible generally. An examination of the opinion of Gunter, J., in that case discloses that such evidence was held to be proper under the issues, but for one purpose, and one only, and the district court in holding the evidence admissible as relevant to a supposed issue of negligence in location clearly misapprehended the effect of the opinion." (89 Pac. Rep. 816-17.)

"Defendant offered evidence to show that there was not known or commercially in use any insulation that was perfectly or absolutely safe under the conditions, and in the circumstances, described by plaintiff in his testimony, and by defendant's witnesses. The court sustained an objection thereto, and this ruling is assigned as error. Defendant had already procured evidence that the insulation of this wire was that which was ordinarily used for exterior wiring. Plaintiff seeks to uphold this ruling upon the ground that the evidence offered was immaterial. In what respect immaterial, learned counsel do not say. The only ground that occurs to us upon which this ruling could be upheld is that, since the negligence averred in the complaint consists, not in improper insulation in the first instance, but failure to keep the wire properly insulated, it is immaterial what kind of insulation was first used, because the highest degree of care in selecting the best known insulating tape would not relieve the defendant of a similar degree of care in thereafter keeping its wires properly insulated through inspection, repair, etc. But from another standpoint its rejection was harmful. As plaintiff himself argues, the jury were, in legal effect, told that, while the defendant's duty was the exercise of ordinary care only, yet, considering the business which it was carrying on, and in the light of the facts of the case, the law steps in and says that ordinary care in such a case is 'the highest degree of care which skill and foresight can attain consistent with the practical conduct of its business under the known methods and the present state of the particular art.' Now, there was no direct evidence as to the actual condition of this wire before plaintiff grasped, or his hand came in contact with, it, and, in the absence of the evidence rejected, only by inference from conflicting evidence produced by the respective parties concerning its subsequent condition could the jury say what such former condition was.

The defendant was not an insurer, and the jury were instructed that no presumption of defendant's negligence arose from the accident. Defendant therefore was not liable, unless the evidence showed that it had omitted some necessary precaution in keeping its wire insulated. Surely evidence that there was not known to the arts or commerce a perfect method of insulation, coupled with the fact, which defendant had already brought out in evidence, that it had used the safest known, was germane, and would help the jury in determining the previous condition of the wire; for while the specific charge was not the failure originally to use safe insulating tape on its wires, but omission to keep it so, evidence that the best known, though not absolutely safe, had been used, would aid the jury in ascertaining whether the method, or lack of method, observed by the defendant in inspecting, or failing to inspect, and repair or renew, the covering first put on, was a compliance with the high degree of care demanded of it. Obviously, if a perfect insulating device was known and not used by defendant, the plaintiff might prove it as bearing on a charge of negligence either in failing to use it at first, or not properly inspecting in order to maintain its contrivances in a proper condition of safety. For a similar reason, defendant should be permitted to show the nonexistence of an entirely safe insulation, which, in connection with evidence that the best known had been used, constitutes evidence responsive to the very issue which the jury must decide. It seems to us that the rejection of such evidence was prejudicial to the defendant, while its admission could not horm the plaintiff. Indeed, in one sense the fact that a perfectly safe insulation is not known might aid plaintiff's cause, in that its nonexistence might require more freqrent and dili-

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gent inspection than would be necessary were an absolutely safe protection available. Similar evidence was introduced in the Lawrence case and commented on by this court as proper to be considered by the jury on the question of defendant's negligence." (89 Pac. Rep. pp. 818-819.)

Electric Lighting and Power Companies and the Police Power

Another phase of this subject concerns the power of the state to relinquish its right to tax corporations formed under its authority either in whole or in part, and the general rule seems to be that the state may provide a particular manner for the taxation of a corporation, and when this method is fixed by the charter of the company its provisions are exclusive and constitutes a contract between the public and the corporation, which the public is without authority to change without the consent of the corporation. This has been affirmed repeatedly by courts of last resort and has been held by the Federal Supreme Court. New Jersey v. Yard, 95 U. S. 104. In this case the charter of the company prescribed a specific rate of taxation and the court held that this constituted an irrepealable contract for exemption from any further taxation notwithstanding the fact that there was a previous general law that all charters should be subject to amendment or repeal. The court ruling points out the ground that there was a subject of dispute and a fair adjustment of it for a valuable consideration on both sides, and gives the statute providing that this tax shall be in lieu and satisfaction of all other taxation or imposition whotsoever by or under authority of this state or in lieu thereof. It is, however, the rule also that the fact that a charter provides a proper method of taxation or a particular rate does not, unless the intent clearly appears, exempt the corporation from the payment of any other taxes. The rule being, that the courts will construe these charters as not providing for exclusive methods of raising revenue unless that intent is clearly apparent from the language of the act. The presumption being that the Legislature or other governing body granting the franchise does not intend to surrender its authority in the matter of raising its revenue. See Farrington vs. Tennessee, 95 U. S. 679, and New Orleans City, etc., R. Co. v. New Orleans, 143 U. S. 192.

It has also been ruled that where the charter of a corporation provides that the corporation shall not be subject to taxation, in other words, where the company is exempted by its charter from the payment of taxes, such exemption is a contract between the state or the public authority governing the franchise and the corporation which is within the intent of the Federal Constitution a contract, the obligation of which may not subsequently be impaired. Pacific R. Co. v. McGuire, 87 U. S. 36 and Wilmington R. Co. v. Reed, 13 Wall. 264 (U. S.).

This power has also been held to prevent the subsequent repeal by the state of such charter exemption and also to prevent the avoidance of the contract by a constitutional convention. Oliver v. Memphis, etc., R. Co., 30 Ark. 128.

Such an exemption when broad enough also covers the individual interests of the stockholders in the company and prevents the taxation of their shares of stock. Tennessee v. Whitworth, 22 Fed. 75.

As in the matter of the rate of taxation, so in the matter of the exemption. The presumption is, that the public did not intend to relinquish its power to compel the corporation to contribute to the maintenance of the state and consequently the exemption must be clearly apparent and must cover the tax which an exemption from is sought. Memphis Gas Light Co. v. Taxing District, 109 U. S. 398.

It should also be borne in mind that in order that these provisions relating to taxation should be protected as contracts by the Federal Constitution, the essentials of the contract must be present and if any of these essentials are wanting, the provision is not substantial as a contract, but may be altered or amended by subsequent enactment. Thus, a mere act of the Legislature which grants the exemption and which upon consideration is not a contract because consideration, that is, the surrender of value, is absolutely essential to the making of any contract. If the consideration is not present, that is, if there has not been surrendered some valuable thing, if some act has not been promised, or if the doing of some act has not been foregone, then the law does not recognize the agreement of the opposite party who did not receive anything, or for whose promise nothing was foregone as a contract It cannot be enforced and consequently is not protected as a contract by the Federal Constitution, so where there is a mere grant in the nature of gratuity of an exemption from taxation, the Legislature may

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at its pleasure repeal this act and may pass a new law imposing a tax upon the company which has hitherto been exempted. Tucker v. Ferguson, 89 U. S. 527.

Constitutions and general statutes providing for the incorporation of various facts ordinarily provide that corporate charters shall be subject to amendment or repeal by the Legislature. When this is the case it has sometimes been held that the Legislature may, as to corporations organized under a general law, reserving the right to amend or repeal, not insist upon the exemption from taxation as a repealable contract when the Legislature subsequently repeals the provisions exempting it from taxation.

The same rules which are here given with reference to the power of taxation apply with the same force to the fixing of rates and if the State has authorized a company to fix a certain rate or to fix its rates within a certain limitation, the State may not subsequently fix the rate which the company may charge nor may it reduce the maximum limit. This rule, however, is subject to the one limitation, that the State may require the company to charge only reasonable rates, even though the charter authorizes the company to fix its rates since that is an implied limitation in the grant itself even though not expressed and consequently the State may legislate subsequently in pursuance of its power so that the company may not charge an unreasonable rate, and what is a reasonable rate is a legislative question in the first instance for the determination of the Legislative Department of the State and in specific instance a judicial question for the determination of the courts. Johnson v. Hudson River R. R. Co., 49 N. Y. 455.

The Influence of the Underwriters' Rules on Electrical Development

By C. J. H. Woodbury.

The commercial introduction of arc lamps for interior lighting was accompanied by numerous fires, whose peculiarity of origin rather than any destructive results gave rise to apprehensions which tended to restrict their use to street lighting until a mill insurance company whose patrons desired to use this method of illumination, made experiments on the subject in 1881 in co-operation with the leading manufacturers of lighting apparatus, and as a result of these investigations a set of rules was prepared which received the approval of all interested parties as establishing methods for the prevention of the occurrences of such fires resulting from the use of electricity for illumination by arc lights.

The preventable nature of such fires was fully set forth at the time in a manner which established public confidence in the safety of electrical illumination, while its advantages were so self evident as to create a natural demand for its introduction. The scope of these pioneer rules was limited to the small isolated plants installed in mills with the crude line of supplies extant at the time, and they were extended from time to time to keep pace with the growing state of the art of electrical illumination and later the conveyance of power. Subsequent experience required that they should be applied to the signalling systems, not from any initial hazards, but solely on account of the exposures of such lines to foreign currents. Thus it will be seen that these rules now take within their scope all of the commercial applications of electricity, excepting perhaps those of industrial chemistry.

Throughout the whole of this work from its beginning, those engaged in the design, manufacture and operation of electrical plant gave of their skill and experience in cordial co-operation with the specialists in the service of the Underwriters, because it was apparent from the first that a single body of rules emanating from a responsible source would be an advantage in concentrating that standardization of methods which would accrue to the benefit of all.

IMPORTANCE OF CONTINUOUS ELECTRICAL SERVICE.

The function of all these applications of electricity is to provide constant service, for in its ability to overcome impediments of time and distance by rapidity of communication, lengthening the natural day, or bridging the gap between the prime mover and the machine, its purpose is impaired by any interruption of continuous operation.

The property loss by a fire which would disable the plant may be a detail of the greater injury from loss of service.

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Its contracts with its patrons are inexorable and must not be tainted with negligence.

In this purpose of furnishing constant service the administrative ability and the technical skill of the various electrical interests have concentrated themselves with results which have proven the effort.

The conditions of a new industry crowded by the demands of customers for its product were inevitably like those of the pioneer on arable soil.

The progress must be made, not perhaps after the manner of those which years of experience and abundant capital would have chosen—but progress must be made.

SUBSIDIARY ELECTRICAL DEVICES.

Every main industry is accompanied by two classes of subsidiaries, and in this electrical development, one consists of those special tools necessary for economical production on a large scale, which form an essential element of present methods of manufacturing in their elimination of economic wastes by reducing costs to their lowest terms; and in the requirement that the commercial unit should be large enough to avail itself of specialized skill in its smallest details.

The other subsidiary class belongs to the lines of small fittings both of pottery and metal, insulations for various classes of electrical service, even special grades of iron and steel, and these have been from the first under the supervision of those especially skilled in such lines of invention and manufacture.

If necessity is the mother of invention, then commerce must be claimed for its father.

These business needs developed all lines of subsidiary industries from the high speed engines to the steam turbine and the impulse water wheel.

The whole line of insulated wires for varied purposes, land cables, fuses, switches and hard drawn copper wire was inspired by the needs of the main plant.

This development required old men's money, and young men's labor, in which it became apparent that the highest grade of technical skill was required, and its greatest work was the establishment of the profession of electrical engineering.

THE UNIFICATION OF THE CODE.

In all things there must be a standard which may be enough beyond realities to be an ideality, but it is in no sense less a guide.

The Underwriters' rules have served as a standard for electrical industries; for passing by details, it holds a place where the varied electrical interests can meet on a common ground for a purpose in which questions of fire hazard may be subservient to that of the arbitrary condition of providing continuous service to their patrons.

The highways must be the routes to reach their patrons, and the relative arrangements either for the limited space underground in cities, which must be shared with water mains, gas pipes and sewers, or in the country where the aerial lines have their places, their perils and their impediments.

The necessity of a standard was so apparent that from time to time many sets of rules were issued by local organizations, municipal boards, commercial bodies, manufacturing companies, insurance associations, technical societies and an organization of salesmen.

One insurance president offered comfort to an electric manufacturing company by an ill-advised letter to the effect that electric lighting apparatus could not cause a fire if arrangements were made by corks or their equivalent so that the lower carbons could not drop out.

These various rules were incomplete within practicable conditions and their mutual contradictions would have been an embarrassing impediment to manufacturers whose plant extended beyond the local market, or those whose operations reached over a wide territory had it not been for the fact that none of them emanated from a source endowed with a sufficient force to make them fully operative.

These differences became so annoying that at a meeting of the National Electric Light Association held at Cleveland, Ohio, February 20, 1895, the initiative for a unification of the rules was undertaken by that body, and arrangements made for a conference of all electrical interests whether manufacturing, operating or insurance, for the purpose of drawing a code which should efficiently serve the desired purpose.

After a thorough canvass of the subject and extensive preparation, this National Conference on Standard Electrical Rules met in New York, March 18, 1896, and devoted several days in consideration of the subject, which consensus of opinion was reinforced by the replies to 1,200 circular letters of inquiry afterwards sent to as many sources where it was hoped to find interested readers.

The vast mass of material was referred to a committee who gave months of toil to the subject and their labors resulted in the National Electrical

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Code which was formally accepted by the various national organizations comprising the active membership of the conference including the National Board of Fire Underwriters, who adopted it as the Code of 1897.

This latter body put the code into type and gave that to the use of the Conference who issued it under the same date.

The work of the Conference was finished in this respect with the issue of its pamphlet, having 42 pages of rules, as its position was merely to take the initiative in an advisory manner, for it was purely a voluntary organization without power or authority to enforce the Code.

These functions were in the hands of the National Board of Fire Underwriters through its relations with fire underwriting interests throughout the United States.

Since that time the conference has been assembled whenever it became advisable for all these interests to hold counsel together and in this manner has continued to serve a useful and conservative purpose.

The Electrical Committee of the Underwriters National Electric Association has continued in charge of the Code, making amendments and additions as the changing conditions of the problem required, always tending towards enlargement until the edition of 1905 is three times as large as the original, in which probably few paragraphs escaped amendment.

The amendments to the Code have largely been the work of joint committees of technical men in the service of the Underwriters and electricians connected with the industry.

For the purpose of broadening the position of the Underwriters on technical questions a laboratory has been established at Chicago which is equipped with apparatus for testing insulation, fuses and subsidiary devices, as well as chemical examinations, but it does not enter into questions of cost or efficiency, therefore, apparatus in chief as generators or motors does not come within its scope.

THE INFLUENCE OF THE CODE ON ELECTRICAL INTERESTS.

These facts are presented to show that the National Electrical Code is fundamentally a consensus of intelligent opinion, and not a bureaucratic ukase, but stands as a composite of the experiences of more persons than was ever given to a question of applied science.

This may be no occasion to deal with the applications of these rules. It has been conceded that this code forms no exception to the principle that every act of executive authority carries with it an equivalent measure of responsibility, and it may be indeed true that in many instances those in the field have not been made duly conservative by the exercise of authority, and there have been demands which were considered to be at variance with both letter and spirit of the rules.

But these instances have been exceptional and the provisions for appeal made by the National Board of Fire Underwriters have resulted in equitable decisions.

It is to be expected that the Code will apply only to conditions bearing on safety against the fire hazard as measured by the final results of experience, for academic provisions which add to cost of installation without contributing to safety cannot be otherwise than a detriment to its purpose.

This Code has been an indirect contribution to the safety of manufacturing properties against fire, for in its purpose to divest the fire hazard from the processes of generating and utilizing electricity, it opened a new era in underwriting which has been applied to other manufacturing methods in providing safer conditions.

The Code as a whole has been an advantage to the electrical interests in its frequent use to settle disputed questions without the slow process of law, and the risk of mischance by judge or jury not understanding the technical questions necessarily involved.

The Code has been of service to electrical development in making standards which encourage substantial methods of construction, and in establishing that confidence which is given to what is permanent and practical.

THE REDUCTION OF THE ELECTRICAL FIRE LOSS.

While the commercial statistics of the fire loss are accurate, the facts relating to the physical conditions of the origin of fires are proverbially inexact, and in the generality of instances based upon presumptions owing to the destruction by the fire of the evidence of its own origin. In the hands of an expert, various minor details may be completed into a chain of evidence, but too often the only information is that of the news-gatherer, eager for a story to fit scare head lines, or it may be that of a culpably interested occupant.

While accidents and palpable deviations from

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the essentials of the Code cause fires of electrical origin, and it is not feasible to apply the logic of figures with certainty as to the final result; yet with far more precision, it may be claimed that the contribution of safety furnished by the Code reaches an enormous although unrecorded amount which has been saved from destruction.

THE DEFENCE OF PROPERTY BY ELECTRICITY.

If the uses of electricity may be in no absolute sense different from other applications of energy it also has its recompenses in the safeguards which it exerts through fire alarms of various types.

These two conditions met together in an instance where an electric light wire crossed with an unprotected automatic fire alarm wire, and the foreign current set a fire for which the automatic apparatus gave the alarm.

We owe to the enterprise of a Board of Aldermen of Boston for the advantage of the electric fire alarm, for the city bought a license under the patents of Channing and Farmer in such a manner that it technically came into the position of a promoter which would arouse the ire of a modern civic reform organization, although the transaction was an honorable one and the result proved to be for the interests of the city, and established the practical value of the fire alarm, and made the way for its introduction in cities throughout the civilized world.

THE TELEPHONE AS A FIRE ALARM.

The earliest application of the telephone in connection with a switchboard was made at Bridgeport, Conn., in June, 1878, where in the emulation of various fire companies to arrive first at fires, the men of Company number 5, which was next to the telephone office, told the telephone operator to request his twenty-one patrons to give the information over the telephone of any wire and to report the fact at the engine house. The engine was not only the first at several fires, but in some mysterious manner was frequently on its way before the alarm struck.

This reached a climax on the occasion of a small fire in a dwelling, which the fire company attended with muffled bell, in response to a telephone message, and no fire alarm was pulled.

On their return the engine was driven by the house of a rival company with bell ringing, and when the men rushed out with inquiries they were told that the fire had been extinguished.

After this occurrence, the chief of the fire department gave orders that companies should not respond to a fire alarm received over a telephone, but the insurance agents of the city appealed to the city council, who ordered that all fire engine houses should be equipped with telephones.

Following this precedent, engine houses throughout the country are equipped with telephones, and in many cities they are bridged together in groups so that simultaneous information may be given in this manner to a number of engine houses, in a manner comparable to telephoning to every subscriber on a party line.

While it may be trite to make the reminder that every telephone is a fire alarm, and in many towns is the only fire alarm, yet some of its miscellaneous applications in this service may not be as publicly known.

While statistics bearing upon the destruction of buildings and their contents receive suitable publicity yet the injuries by fire to standing timber may not be so widely promulgated on account of the fact that such property is not insured.

The Forestry Bureau states that this destruction amounts to ten per cent. of the value of the normal yield of lumber and to this should be added the further loss caused by the impairment of the young growth by such forest fires.

The government forest preserves in the West are equipped with telephone lines to which the forest rangers can attach their portable telephones, and when alone, they can attack fires with greater efficiency, as they know that all available reinforcements are on the way, and it is not necessary for them to make provision for retreat which might otherwise be necessary.

Private enterprise in the lumbering regions at the northeast keeps observers on high mountains, and from their point of vantage, information of forest fires is telephoned to towns or to lumber camps, where help can be obtained.

English fire brigades have special telephones in the helmets of the men, who are thus able to communicate through portable wires from a building to their officers.

CAPTAINS OF ELECTRICAL INDUSTRY.

In considering any phase of applied electricity one cannot credit too highly the work of pioneer inventors groping their way by the light of their own genius to the achievement of such useful results.—*Read before the New York Electrical Society.*

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Advertisements, Changes in Advertisements, and Reading Matter intended for the next month's issue should reach this office not later than the twenty-fifth of this month.

No commissions are allowed on advertising contracts or subscriptions.

Entered at the New York Post Office as Second Class Mail Matter.

Relative Lighting

The comparison of light obtained from different sources, gives some foundation in practice, for the opinion expressed by merchants, storekeepers, etc., that their preference is based upon reasonable grounds, and not upon mere fanciful taste.

For instance, it is well known, that different kinds of illuminants produce correspondingly different groups of light waves, which though not essentially different from each other, still represent sufficiently marked changes in this respect to be characterized by consumers of electricity as the incandescent, arc, or other light, as the case may be.

The installation of a uniform system of lighting therefore, in any large establishment may, while productive of satisfaction as far as the amount of light is concerned, be anything but satisfactory because of the personal element of "like" with respect to certain kinds of light that has in this instance, not been entertained. In other words, the merchant or storekeeper, must be forced to pass an opinion after sufficient ocular demonstration has been made to him, regarding the form of light, which is not only best suited to his establishment, but which he feels assured he likes, as well.

The personal tendencies of those, whose consumption of electricity or light, is now a marked feature of all large cities, must be consulted, not only for commercial reasons, but because of the necessity for implanting particularly in this class of men the idea, that various forms of light are not in themselves always responsible for the light "impression" produced. The rather lax tendency observed in matters of vital interest to the commercial world, and the severely strict adherence to fundamental rules pertaining directly to business life, form rather a strange contrast in the eye of the keen observer.

Adherence to rules in business life, are naturally and admittedly the only means of sustaining it, but the neglect of other secondary principles, to which business life is related by the strongest ties, has been one of its greatest peculiarities. While swift to take advantage of things directly within its sphere, the world of business has not been as fast to get down to the roots of electric lighting, and thus make use in a commercial sense, of the knowledge obtained, as opportunity has provided. For this reason, business men of limited experience, who only know that they want their places better lighted, are apt to offer eithes strange opinions before the light is installed or equally strange objections after it is in.

The effect of paint of various hues, wall paper and a mixture of daylight and artificial light upon the eyes and the æsthetic sense, has not been analyzed sufficiently by this class of men, to show that some of their impressions are entirely false and others however strong, very untrustworthy. The various degrees of absorption of light by white, yellow, pink, blue, red, etc., are, as far as this information goes, an undiscovered country to the man only interested in direct profit and loss, as seen in cash alone. Profit and loss are just as visible in the secondary things encircling business life, though, strange to say, they are very much neglected by those repre-

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senting it, because it seems forsooth to belong to another sphere.

If two places are of equal size, and one is painted or papered with a white or whitish color, and the other with yellow or a yellowish tone, the fact that a difference in light absorption of 18 per cent. in the white and 40 per cent. in the yellow takes place, means in the business world that a responsible choice must be made by the one to whom these facts are known.

On the other hand, if one source of light is supplied with yellow rays in abundance and another source of light with white rays, the lighting effects will contrast to the extent of making the room seem lighter with one than the other, though the amount of candlepower may be identical in each case. The truths so readily discovered regarding not only the tint, or color of the surfaces to be illuminated, but the light which produces the illumination, are at the command of everybody. An immense amount of controversy and disagreement would be eliminated, were the true facts regarding light, put plainly before the chief individual consumers.

To some extent collisions occur, between the so-called æsthetic experts and the light expert. These are due to the fact that one may demand a color of great light absorbing properties like red for instance, and the other limited in the use of light, may find it impossible to properly produce the effect of substantial illumination in consequence.

The subject of optics and light mixtures occupies an important place in the consideration of commercial light sources. The reason for this is found in the refusal on the part of the public to endure light that is not pleasant to the eyes and senses. In other words, the nervous system is responsive to the effects of certain forms of light, such forms for instance, where the preponderance of certain light waves over others is productive of unusual color relationship. Thus a comparison of light effects occupies an anomalous place in the science and practice of electric lighting.

Power Lost in Moving Parts

Friction, in steam engineering, is regarded as the destroyer of economy. Efficiency, from the coal pile to the lamp, represents a series of changes, whose final evolution into light, comprises items, each of which may be destructive of the ultimate purpose in view. Moving parts always consume power, whether they appear to be insignificant in this respect or not, and the amount of power they consume is not always appreciated by those even most familiar with the action of the machine.

Some German tests may prove to be sufficiently illuminating in this respect to show how flywheels constitute a waste of power. To quote, from the publication in which the data appeared, namely, the *London Electrical Engineer*: "The station in question was provided with two tandem compound engines of 450 horse-power, direct coupled to the dynamos, and working at 95 revolutions per minute. In order to equalize the running with the great variations of load which occur, a very heavy flywheel was used with the arms of a channel section These arms were found to offer great resistance to the air and to create a powerful draught. It was, therefore, decided to cover the wheel with sheet iron in order to reduce the resistance and thus gain considerable power." The result of this change is noted in the data which follows; with no protecting covering, the flywheel took 3,426 watts more than it did with a covering of that character. This means 5.7 horse-power, which when figured up per day and year, represents several hundreds of dollars loss in power. In another test recorded by the same experimenters, a 630 horse-power engine showed a loss of 30 horse-power because of the resistance of the arms of the flywheel to the air.

It is quite natural to infer from this that thousands of cases exist in which the flywheel acts as a brake or a consumer of a large percentage of energy, due to its fan effect on the air. This is readily changed by the use of a web or covering for the spokes as suggested. And in addition, it may be noted, that the other moving parts are consumers of large amounts of energy through friction due to bad surface in contact or too much tightening.

Wherever there is reciprocating motion, there must be friction, however carefully the parts are fitted; but the fitting being complete, some effort ought to be made to present surfaces to the air, that are not consumers of much energy on this score alone. Perhaps the steam turbine possesses advantages that have not been entirely noted in this respect as yet, and have thus far been attributed solely to the internal dynamic excellence, when the collective efficiency may in fact be due, partly to the elimination of air resistance outside the machine.

The moral of this argument is readily discerned, when a consideration of the brains, money and effort

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made to gain a little advantage in efficiency is remembered. Per cent. by per cent. the reciprocating engine has crept to its maximum of output with a minimum of absorbed energy, and the utmost care has been necessary in accomplishing this, not to overlook any detail in construction that might lead to this result.

It would seem strange, therefore, if the science of design conflicted with the constructive art of practice. Occasionally, lack of coördination in this respect has manifested itself, and the result has been a marked loss through which all the brain effort at one end of the task has been disregarded by the muscle effort at the other end. There is nothing surprising on such grounds in the fact that engine tests show losses in output through moving parts and particularly flywheels. There is nothing surprising in the acceptance of old methods as the right thing, when the most modern thought has been bestowed upon the design. More agreement or understanding between the engineers' department, the shops and the testing room would be sure to end such possibilities of error at the last moment.

Phase Transformers

Specific cases are generally regarded as the best means of driving home a lesson of technical importance, but the disadvantage at times is that they represent only one aspect of a fundamental principle and may, therefore, be misunderstood. The general principle, however, which has obtruded itself upon the notice of engineers is the efficiency with which phases can be transformed in plants of large or small size and thereby made the means of sustaining a high general efficiency in the total operation.

In Arizona a plant is in operation in which single phase machines are employed for the purpose of supplying two and three phase currents as well as direct current to the distributing section. Without it being necessary to go deeply into the details of this equipment, the point advanced is this: that the phase transformations can be handled with as much elasticity as the raising or lowering of the potential. One of the unique features of this latter day practice in power transmission is the general acceptance of the theory and fact that it is as necessary to have control of the phases to gain efficiency commercially and scientifically as it is to control the rise and fall of pressure. On these grounds at least, the rapid strides made in power transmission place this country far ahead of any other country in the world in its use of natural power supplies for municipal and industrial purposes.

Another point of importance that must be referred to in connection with phase and pressure transformations is that of frequency transformations as well. The efficiency of a plant is thus enhanced far beyond what was ever entertained a decade ago by this triple opportunity to meet conditions satisfactorily. Originally, the raising and lowering of the pressure had to be met with successfully by advancement in the design and construction of transformers. Following this came the advance in the methods of handling the different phases by means of new designs of circuit and inventions in transformer construction. Contemporaneous with that came the use of machines as frequency changers, thus giving a complete and certainly a most comprehensive way of meeting all difficulties in power transmission in so far as they were affected by these influences. To sum up, it may be said, that the features now in hand in power transmission are control of the potential, phase, frequency and insulation. These have been stumbling blocks in the past, to-day they are in our hands, as the means of developing all of our great natural sources of power.

CURRENT IDEAS

For Furnishing More Light, Heat and Power from Central Stations

Electrical Co-operator's Creed

By Chas. A. Parker.

I believe in Electri-city—the greatest "city" on Earth.

Daughter of Science and Mother of Progress.

Sister of Civilization, Handmaid of Industry and First Cousin to the Spirit of Peace on Earth and Good Will to Man.

Lightener of Burdens, Tamer of Wilderness, Annihilator of Distance and Goddess of Light.

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The most necessary of luxuries.
The most luxurious of necessities.
Who wouldn't believe in Electricity?

I believe in coöperation.
Pennant-winning "team work," rather than individual grandstand play.

Constructive and profitable combination as opposed to destructive unprofitable competition.

Greater general progress through reduction of individual friction.

Working together for the Grand Prize instead of quarreling together over scanty profits.

Coöperation—who wouldn't be a coöperator?

I believe in Electrical Coöperation.

"All together, all the time, for everything electrical." The application of the Highest Law of Modern Business to the Greatest Business of Modern Times.

The massing of forces to boost the sale of current and everything under Heaven that uses current —the Generator of an enlightened "Current Opinion."

The step-up Transformer of low-efficiency selfishness to high-voltage helpfulness—the Incandescence of enthusiasm against the resistance of Conservatism—and the Short Circuit to the final and complete Electrification of the Universe, and to that Millennium Age when what isn't done by electricity won't be done at all.

By Frank B. Rae, Jr.

I believe in coöperation.

I believe that if one-half the time, labor and money now spent in commercial strife within the electrical trade, were turned to account in combating the natural competitors of the trade as a whole —if but a small amount of the energy now dissipated in fighting for the business that exists, were devoted to the creating of new business—it would redound to the advantage of all.

I believe that this great advantage to all cannot be secured without the sacrifice upon my part, of certain small advantages, the burying of certain animosities and perhaps the loss of certain immediate gains; nevertheless, I believe I am sufficiently broad-gauged and far-sighted to forego the lesser advantage for the greater.

I believe that this can be done without the submerging of my individuality or the loss of any material advantages which I will get back many fold, and of petty pride, which I can well afford to be without.

I believe the time for coöperative action is here. I am ready if you are.

By Paul Lupke.

I believe that my first duty is to care for those who are dependent upon me. I believe that to fulfil that duty faithfully under present social conditions I must avail myself of the help of my fellows and I believe that to secure that help fairly I must extend it as freely as I ask it.

I believe that the existing complexity of interests compels me to single out one and to work for that interest with unvarying fixedness of purpose.

I believe that in doing this, and to be a man among men, I must rise above nagging and knocking, small jealousies, petty wrangling and tainted competition.

I believe that my individual advancement is linked with unseparable ties to the advancement, as a whole, of the interest I have chosen to represent and that whatever I can do to further that interest must invariably further my own.

I believe that success and prosperity are natural conditions, that failure and commercial calamity are unnatural and man-made, and that I must preach and act success and prosperity with unfaltering cheerfulness.

I believe that true contentment can be gained only through the consciousness of work well done and that, since my chosen interest is Electrical Development, I must unite with my fellows in working—all together—all the time—for everything electrical.

By Lewis L. Brastow.

I believe in the Cause, in its present worth and future greatness.

I believe in the man who represents it.

I believe that the coöperation of such men in such

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a cause divides the load and multiplies the power, that it carries its message faster, serves its public better, and gains for each a larger share in the merited reward.

I further believe that lack of Unity means waste of energy, weakened effectiveness and narrowing horizon.

I believe in hard work, in cheer, in loyalty, in honor, in intelligent work and that enthusiasm for the common good which willingly divides and eagerly assists.

I believe in our motto and that in the spirit of All together All the time, the standard which we hold, we cannot fail to win the Cause for Everything Electrical.

By S. M. Kennedy.

I believe that in the civilized world to-day electricity is the greatest agent for doing the greatest amount of good to the greatest number of people.

I believe that in advocating the use of electrical service I am helping to make life more cheerful, hopeful, healthful and useful for all classes of people.

I believe it is desirable to take advantage of every opportunity to increase the sale of electrical energy, and that coöperation points to many opportunities for the use and development of electrical service which might not be discovered by individual effort.

I believe that every man engaged in the electrical business knows something about it which I do not know, but which I would be the better for knowing. I believe that coöperation is the best means for me to obtain such additional knowledge.

I believe that the true interests of electrical distributing companies and manufacturers of electrical appliances are identical with the interests of consumers, and that coöperation is essentially to the advantage of all.

I believe that the coöperation of the public is necessary for the permanent upbuilding of a distributor's business, and that this coöperation can only be obtained by means of good service, square dealing and courteous treatment.

I believe in the efficacy of individual effort, and that the way to obtain the fullest advantage from individual effort is by coöperation.

I believe that the best test of all work is results, and that in the coöperation of individuals, corporations and associations towards a common end, the highest results are assured.

I believe that the chief aim in my daily work is success, and that coöperation will help me make the victories of to-day the stepping-stones for the achievements of to-morrow.

I believe in the potency of persistent labor, and that in order to enjoy the full fruits of my labors, I must be a coöperator with others who are working along similar lines.

I believe that the time to coöperate is now—and always.

By Richard E. Brown.

I believe in electrical coöperation; in its soundness; its wisdom and in its value to my associates and myself, individually and collectively.

I believe in the more extended use of electric current by the public for light, heat and power, and that through coöperation this result can be best obtained.

I believe that the interests of the allied electrical industries are my interests; that I am best serving myself by coöperating with them to the best that is in me.

I believe that I cannot know too much about things electrical; that the individual who daily acquires some fresh knowledge; who makes some little advancement each day, is the man who in the end comes to the top, and that coöperation is the means to the end.

I believe that the interchange of ideas, experience and suggestions is bound to be of mutual advantage; that men succeed only as they utilize the ideas and services of other men, and that coöperation is the key-note of success.

I believe in the necessity of harmony and in the loyal and hearty support of every man connected with the electrical industry to the principles of coöperative work.

I believe that coöperation means education, progress, efficiency and prosperity.

I believe that in unity there is strength, both individually and collectively, and that success will come by working "All together all the time for everything electrical."

I believe that coöperation is the most effective way to secure the most of what each one desires to obtain.

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I believe in electrical development through coöperation.

Therefore, I will be a coöperator.

By Chas. W. Lamb.

I believe that two horses can pull a bigger load than one. Same with men.

I believe that two men can do more by pulling together at the ye-o-ho than by pulling apart. I believe in the ye-o-ho.

I believe that I know a good deal, but some other men knows something I don't know. I can use that something.

I believe that a wise man learns from everybody —and shares his wisdom to get more.

I believe that the more people know of electricity and its appliances, the better they like it. I believe in teaching them.

I believe that most doors open inward. Therefore in PUSH.

I believe that the electrical business is interdependent, and coöperation is the key-note.

I believe in sense, sand and suavity—in treating my customer as an intelligent gentleman. Then he will discover that I'm one.

I believe in giving my co-worker in the electrical field the glad hand of honesty and help and in grasping his as heartily.

I believe that the only pull is pulling together—"All together all the time for everything electrical."

By J. R. Cravath.

I believe that coöperation is to be the life of the electrical trade.

I believe that more electrical supplies and current can be sold by boosting everything electrical everywhere, all the time with emphasis on my own goods, than by knocking the other fellow's goods to sell mine.

I believe that electric light and power service ought to be used much more than they are and for more things than they are.

I believe that the first thing for every electrical man to do is to set the example by using all of these electrical necessities, conveniences and luxuries himself and then to talk about them to his lay friends.

I believe that until electrical men make daily use of these conveniences, they are talking from a second-hand knowledge only and are not likely to enthuse the public much about them.

I believe that it is only by pushing that the general public can be brought to appreciate and use electrical conveniences, and that this pushing should be done by electrical men all together, all the time.

By Hugh A. Brown.

Whereas,

A single ampere turn of wire on an iron core will produce but a very insignificant magnetic attraction, though the ampere turn is the fundamental unit of the most powerful magnets; and,

Whereas,

A single incandescent lamp would look pale and lonesome if used alone to light a ball-room hall, though the incandescent lamp is the fundamental basis of the most brilliant and successful ball-room illumination; and,

Whereas,

A single arc lamp applied to the lighting of a city's streets would be practically useless in preventing the after darkness crimes of metropolitan life, though a sufficient number burning in unison throughout the night lend the safeness of a day to a city night; and,

While,

A single ton of coal, a single boiler, a single engine, a single dynamo, or a single electric car may be hopelessly inadequite to move the passenger traffic of a city's streets, yet the traffic of the streets of many cities is being smoothly and quickly moved by the combined united efforts of many such units. Hence, it is evident:

That what is true of the physical forces, which we direct, and of their applications to the arts and inventions, which reflect ourselves in nature, is equally true when applied to our own efforts, and not only corroborates the national axiom "In Union there is Strength," but evolves the commercial corollary "In coöperation lies comprehensive success." Therefore, be it resolved:

That we believe in coöperation as the natural supplement of individual effort.

That what benefits one in the electrical profession raises the general average of success to all.

That our own success and happiness in life depends largely on the success of those associated with us, and,

That everything we do which promotes the interest of the general profession, and the business whereby we gain our livelihood, is indirectly a step in the promotion of our own personal welfare.

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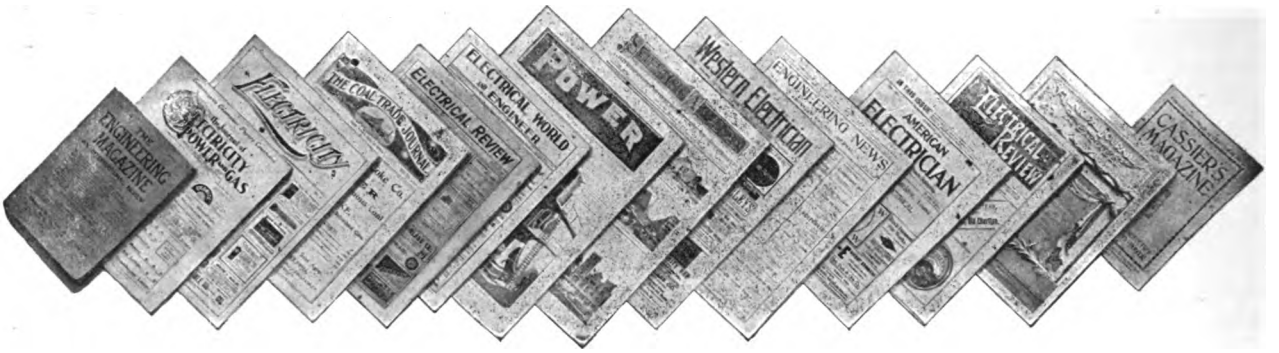

MONTHLY REVIEW OF THE TECHNICAL PRESS

Efficiency of Dirty Coal

In a paper read before the Western Society of Engineers by Mr. W. L. Abbott some interesting remarks are made with reference to the efficiency of coal containing much ash. Though we rarely have to do with coals containing such ash percentages as 20 or 30, it may sometimes happen that the question of the use of such coals will come before the engineer, and as time goes on coal will be found to contain more rather than less dirt, if sold as it is got.

The question of washing coal is brought more into prominence, and incidentally also the use of gas power rather than steam power, for the loss of efficiency when dirty coal is used in a producer cannot approach the loss when it is used beneath steam boilers.

Mr. Abbott describes experiments made with coal screenings, which were burned under Babcock boilers with grate areas of 75 and 66 sq. ft. and heating surfaces of 5,000 and 4,000 sq. ft. Each boiler had a chain grate stoker. It was sought to discover the effect on capacity and efficiency of using different sizes of coal, the influence of the ash, the effect of variation in size of coal screenings and the results of different thicknesses of fire.

Thus one set of experiments was made with coal screened through square meshes of 0.25, 0.50, 0.75, 1.0 and 1.25 in. All the samples were screened from the same coal, and the smaller sizes consequently had the most ash, the percentages of ash of each of the above sizes being 30.8, 20.8, 15.6, 14.0 and 13.7 respectively. While the largest size gave an efficiency of just over 60 per cent., the efficiency rose to a maximum of 70 per cent. with the 0.75 size, fell to 65 with the 0.5 grade, and dropped to less than 30 per cent. with the smallest grading.

The capacity or boiler-power curve followed a similar, but steeper curve with a maximum point near the 0.75 size on the side of the 1.0 size, but while the maximum capacity is 900 horse-power, the minimum is only 100 horse-power, showing that, with but little more dirt, the boiler would do little else than keep itself warm.

Ash acts as a diluent, displacing combustible matter, and in another series of tests made with a special washed coal passed over ¼-in. round openings, and through ½-in. round openings, it was found that with coal of 14.463 b.th.u. when pure, and 13.176 b.th.u. with 8.9 per cent. of ash, in the dry sample, a certain efficiency was attained. In subsequent tests ashes were added, and when the total ash was 40 per cent. of the whole mass, the useful effect was zero; that is to say, the boiler just managed to keep itself hot. Thus, with a fuel containing 60 per cent. combustible, no work external to the boiler could be performed, owing to the obstruction caused by the ash and the small amount of combustible on the rear end of the grates, so that much useless air entered and the temperature head of the gases above the heating surface was too small for useful effect, the general furnace temperature being reduced to perhaps 600° F., so that the boiler could not absorb more heat than what was required to balance radiation losses. This point is particularly emphasized, and it bears closely on much modern practice, showing the extreme fallacy of

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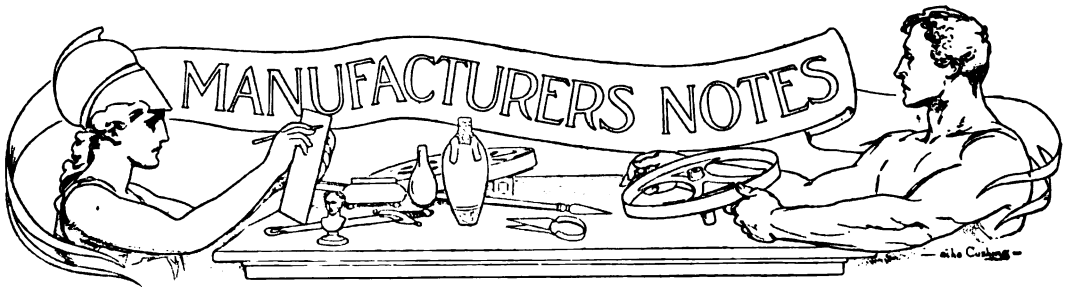
controlling furnace temperatures by the admission of excessive air with the view of enabling such things as superheaters to withstand the temperature of the gases brought against them. Needless almost to say that, so let down, the huge volume of low temperature gases which leaves a superheater is almost useless for further heating purposes.

Another set of tests was made to determine the effect of variation of size of coal screenings. Fine dust in excess is a great source of trouble, and washing the coal necessarily improves the coal by removing the dust. A coal sieved through a 0.25-in. square screen gave 108 horse-power, and a washed coal through 0.25 round hole sieve gave 600 horse-power, but not much of the difference is attributed to the reduction of ash by the washing. It is the dust to which the reduced capacity is attributed.

As regards thin and thick fires, the former give an excess of air and the latter tend to smoke. With a badly set boiler, the gases rising directly amongst the tubes, the best economy accompanied the most smoke, because with the chain grate and thick fire the air excess was reduced. About 5½ in. was the fire thickness for best capacity, but the efficiency did not vary. The paper is somewhat involved for complete and satisfactory abstract, but is an earnest attempt to discover laws bearing on coal sizes and ash contents. It is remarked that in 1905 there were produced 50 millions of tons of coal in Illinois and Indiana, and of this quantity 48 per cent. was 1¼-in. screenings; it can be truthfully said that this percentage, or 20 million tons, was sold at the mine at a price which, on an average, was not over two-thirds of the cost of production, and this fine coal was employed to make steam at an average efficiency of less than 50 per cent.

Such facts as these certainly warrant the further prosecution of the inquiry, for if substantiated, they point to the relatively enhanced value of large coal, and especially to the economy that would be obtained from gas engines, as compared with steam plant, given, of course, a suitable bituminous producer. Whether an investigation on similar lines into English coals would show the same general results, we can hardly say, but the subject is one of great importance, and tests ought to be made with rational furnaces properly constructed to burn bituminous coal without smoke, and not merely upon grates disposed directly below the water tubes of a boiler in a furnace hopeless of all possibility of suitable air admixture and innocent of any means for maintaining temperature, pending the sufficient progress of combustion to warrant exposure of the gases to heat-absorbing influence.—*London Elec. Review.*



West Allis, Milwaukee, Works of Allis-Chalmers Co.

Although the manufacturing facilities of Allis-Chalmers Company are distributed among seven large plants, located in the principal industrial section of the country, each of which is an efficiently organized unit, to one who has made a tour of inspection of the mammoth works at West Allis it would appear that with such shops and equipment the output from these works alone would be suffi-

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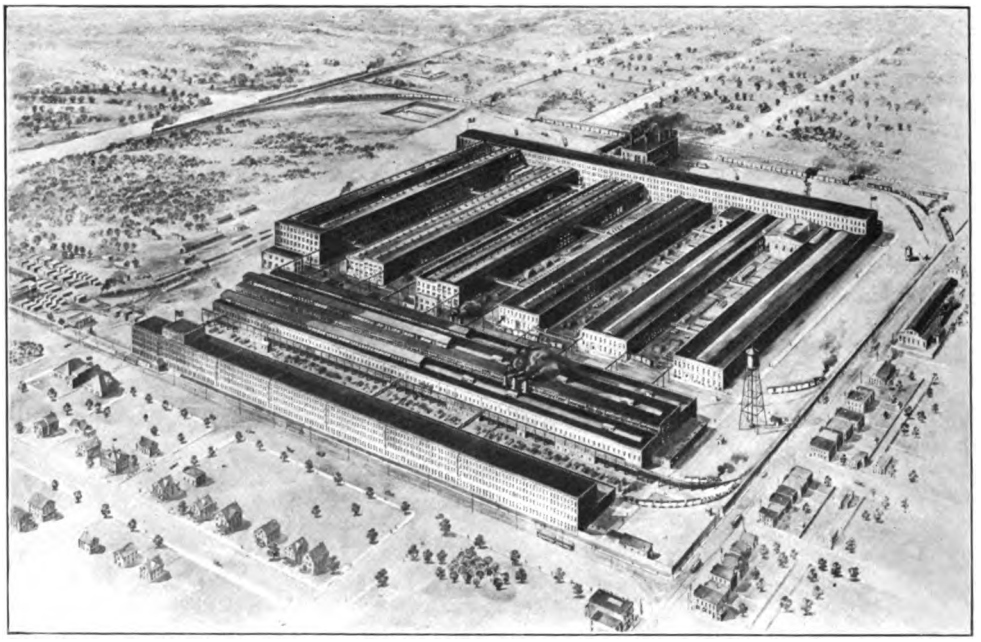
cient to supply the demand for all the machinery that could be marketed by a single company in the face of modern competition.

And such might be the case if Allis-Chalmers Company's activities were restricted to the building of power machinery alone, including prime movers of every description, electric generators and auxiliary apparatus of all kinds; but when it is recalled that this company not only stands first in this field—enormous as it is—but also leads the world in the manufacture of other machinery for industrial purposes, it will be seen what piant powers must be under control and what extensive shop facilities must be always available and in operation to provide for filling the stream of orders that daily, monthly, yearly, pours in from every quarter of the globe.



ALLIS-CHALMERS CO. WORKS, WEST ALLIS, MILWAUKEE.

As a result of the compact arrangement of the West Allis works, it is only after having inspected them, unit by unit, that the visitor begins to comprehend their great extent. Some idea of the size of the plant may, however, be gathered from the fact that the area of the ground upon which the works are located covers 110 acres. The yards about the works are covered with a network of railroad trackage, supplemented by an extensive system of cranes and tolophers, giving unexcelled facilities for handling heavy work of all kinds. This trackage aggregates over 12 miles in length. The extended works have been provided with a new power house with a capacity of 10,000 h.p. in turbines, gas engines and reciprocating engine units. Cooling and condensing water is provided in an open reservoir of 5,000.000 gallons capacity, which is 260 feet long, 200 feet wide, and 15 feet deep and supplied from artesian wells.

The largest building of the group, the erecting shop, is 1,160 feet long, while the foundry and pattern shops are each 960 feet in length. The six machine shop units are each 580 feet long. In the construction of this great group of buildings immense quantities of building material were used. In the addition alone the following is a partial list:

19,000 bbls. Portland cement,

785,000 feet of roof sheathing,

850,000 feet of yellow pine and white oak,

150,000 square feet of wire glass, or a total of 17,145 pieces.

There are 102 traveling cranes installed in the various buildings and storage yards of the works, whose total lifting capacity is 4,030,000 lbs. or 2,015 tons.

No other industrial plant in the country has devoted such an extent of space to a single department of the foundry. The scale of the operations carried

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on here daily is shown in the fact that single castings weighing over a hundred tons are made for slides and bed plates of Allis-Chalmers engines without causing the slightest disarrangement of other work. The pouring of four hundred tons of metal in a single day into gas engines, steam turbines, steam engine or large electric generators and motor castings is no unusual occurrence. The melting capacity of the foundry is approximately 520 tons daily.

The area covered by the West Allis works is divided between storage yards, trackage, runways and actual enclosed floor space of 1,438,786 square feet, every portion of which is actively and continuously utilized in the construction of machinery.

Allis-Chalmers employees number in all approximately 14,200, of which over 300 are employed as engineering experts in the various departments of its organization.

Demand for White Star Oil Filters continues to show no let-up and this fact proves to the Pittsburg Gage & Supply Co. Pittsburg, Pa., that prosperity still showns no signs of a let-up despite any statements to the contrary. Among those concerns who have purchased these filters during the past month are the following:

Walter Baker Co., Boston, Mass.
Union Ice Co., Quinnimont, W. Va.
Canton Home Brewing Co., Canton, O.
American Cast Iron Pipe Co., Birmingham, Ala.
Pittsburg Buffalo Co., Burgettstown, Pa.
Anniston Fertilizer Co., Anniston, Ala.
Ivanhoe Furnace Co., Ivanhoe, a.
Atlantic Suburban Elec. Co., Atlantic City, N. J.
Taunton-New Bedford Copper Co., New Bedford, Mass.
Schenley Hotel, Pittsburg, Pa.
West Virginia Brewing Co., Central City, W. Va.
Southern Steel Co., Ensley, Ala.
Crystal Laundry Co., Cumberland, Md.
Tenn. Coal, Iron & R. R. Co., Ensley, Ala.
Columbian Canning Co., Lubes, Me.
Flynn Lumber Co., Swiss, W. Va.
McGhee Lumber Co., Dallas, Fla.
Alton Pacing, B. & F. B. Co., Alton, Ill.
Evansville Brewing Assn., Evansville, Ind.
Electrical Developing Co., Niagara Falls, Ont.
John Westwick & Son, Galena, Ill.

"Practical Illumination," is the title of a new work by Mr. James R. Cravath and Mr. Van Rensselaer Lansingh, which is unquestionably, as the title indicates, one of the most practical as well as being the most up-to-date work of its kind published. The book consists of 356 pages, and is fully illustrated by diagrams and illustrations of the right and wrong way to distribute incandescent lamps and other illuminants, with their shades, globes and reflectors to obtain the various lighting effects.

The object of this work is to present exact practical information for every day use on many points that come up in arranging artificial lighting. No attempt is made in this work to illustrate or describe the apparatus for the production of light, but it is confined to getting the best and most efficient effect from the light after it is produced. The book abounds with tests of the light distribution of various illuminants with different styles and shapes of globes, reflectors and shades, and as most of these tests were made by the Electrical Testing Laboratories, of New York, they, of course, are as accurate as it is possible to make them. Beside each curve of light distribution a cut of the globe, reflector or shade is shown, from which that curve was taken, thus enabling the illuminating engineer to see just what curve of light distribution he may expect from the different shapes of globes, and make his selections accordingly.

The foot-candle is adopted in this work as the unit of intensity of illumination upon any surface upon which the light may fall.

The chapter of Demonstration Room Tests is most interesting and practical, as it shows by illustrations the effect of various shades, which could not probably be understood by the layman from the diagrams of light distribution. This book is published by the McGraw Publishing Co., of 114 Liberty street, New York City, and should be on the shelf of every electric lighting station in this country. The price of the book is $3.00. It is 6 by 9½ inches, and is handsomely bound in dark blue cloth.

The Atlantic Coast Line Ry. Co. have installed at South Rocky Mount plant, a 5-ton, 3 motor electric northern traveling crane, span about 72 feet. This crane was furnished by the Northern Engineering Works, Detroit, Mich.

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The Westinghouse Electric Works at East Pittsburg, have established another new record. This time it is in the shipping department. During the month of May the company shipped no less than 750 carloads of electrical machinery, or an average of 30 carloads a day, aggregating 10,000 tons and representing in value about $4,000,000. This exceeds by 110 cars any shipping record for one month that has ever been made at these works. The high record heretofore was held by the month of August, 1906, when 640 carloads were shipped.

The business of the company is keeping up as usual, the orders for May approximating close upon $4,000,000. There has not been any let-up in this respect since the first of the year.

"Transformer Testing for Central Stations," is the title of a little illustrated pamphlet recently gotten out by the General Electric Company, showing in a simple and concise way the method of making all the necessary tests required on this class of apparatus in central station practice. Examples are given as well as diagrams, formulas and tables, and this little pamphlet should be "on tap" in the construction department of every central station in the country.

If you haven't received a copy, the above company will be very glad to send it for the asking.

Messrs. Dunton and Field, 117 Main street, Cambridge, Mass., manufacturers of the Dunton tree insulator, which has become the standard insulator for all classes of tree work, are receiving most complimentary reports regarding the efficiency of their insulators, which are now being adopted by so many of the electric lighting and power stations all over the United States. The United Electric Light Company, of Springfield, Mass., one of the many and large users of these insulators, stated, after giving them a long and severe test, "We think it is the best thing of the kind we have ever seen." The above company issues a very convenient little illustrated price list of these insulators, and any central station manager who has been troubled by the scraping off of insulation on any of his lines, due to the chafing of the limbs or branches of trees, should write to this company, whose insulators, which are easy to install, will prevent any future trouble, and will pay for themselves many times over in a short time.

The Minneapolis Steel and Machinery Co., of Minneapolis, Minn., in order to take better care of their growing trade in Montana, have recently opened an office at 352 Phœnix Building, Butte, Mont., under the management of Mr. J. L. Lanning.

The Chase-Shawmut Company have just issued to the trade a very attractive fifty-eight page booklet, pocket size, covering their complete line of fuses. bases and fittings. In addition to their regular line this catalog presents a number of specialties which have recently been placed upon the market. Containing over one hundred illustrations and considerable valuable data this catalog will be eagerly sought by all interested in this class of material.

General Electric Company's Exhibit at the Jamestown Exposition

Although electricity plays a most important part at the Jamestown Exposition, the management felt it advisable not to set aside a separate building for electrical exhibits. Two principal exhibit halls have been built. One of these, the Machinery and Transportation Building, includes the exhibits of electrical machinery, and it is in this building that the main sub-station and distributing switchboard of the exposition are located.

Inasmuch as all of the electrical apparatus in the sub-station, as well as that used by the Exposition Company around the grounds, was furnished by the General Electric Company, its exhibit has been confined to illustrating various industrial and domestic applications of electricity. This exhibit is located adjacent to the sub-station, and is filled with a most interesting variety of devices, many operated by electric motors. One section has been fitted up as a model electric kitchen with a spacious dining room adjoining, which will be used as reception quarters for guests.

One of the interesting features of this exhibit is the small refrigerating plant operated by an electric motor so arranged that the refrigerating liquid passes through an adjacent section of the railing, which, of course, is covered by a heavy white frost. Another unique application of the electric motor is seen in the Seth Thomas clock with 24-in. dials in full operation, regularly wound by an electric motor. An electrically operated floor surfacer and polisher is worthy of comment. A motor-driven washing machine attracts the housewife as much as

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the sewing machine, operated by electricity. The electric cream separator is not quite generally used, and this company is furnishing the motors for driving an exhibition where cows are milked by electricity in another part of the grounds.

Up-to-date bakeries are now equipped with electricity for operating as well as lighting, and the electric dough-mixer, shown by the General Electric Co., has proved a most useful device. The designs of electric hair driers are here exhibited, and the electric heating pad is also shown. The electrically operated circular saw and new form of electric bench drill, motor-driven lathe, and a small portable forge, fitted with electric blower, form an interesting part of the exhibit. There are also a number of small grinders, buffers and polishers for use of jewelers and in small shops. Several types of ventilating blowers are shown, and the exhibit of ordinary electric fans is very complete. In fact, this promises to be one of the most useful parts of an exhibit located in the latitude of Norfolk.

In the electric kitchen is to be found an elaborate collection of the General Electric Company's electric heating and cooking utensils. These will be in full operation during the exposition, and their convenience and durability will be amply demonstrated.

The dining room is attractively fitted up in Flemish oak, with dark red burlap wall covering and contains a handsome mantel of Flemish design. Instead of the gas log, the luminous electric radiator has been installed in the fireplace. In the ceiling of the dining room a comprehensive showing is made of the company's incandescent units, including the Gem units of various sizes, and the new Tantalum lamps, all equipped with various forms of Holophane reflectors.

The main part of the exhibit is illuminated by G. E. enclosed arc lamps, fitted with concentric diffusers. Edison incandescent lamps are used throughout for lighting the exposition buildings, and the General Electric Company exhibits this type of lamp as well as some of the other standard Edison lamps, with interesting information as to the annual production, etc., of these lamps.

As indicative of certain uses of the electric motor an Edison business phonograph with shaving device is exhibited, as well as a talking phonograph, all operated by small motors. The talking phonograph is used to explain the operation of the other phonograph and various devices in the exhibit. An electrically-driven house pump is shown in operation, and an electric renovator in the form of a carpet sweeper form an unusually interesting application of the electric motor.

The General Electric Company will also furnish for use about the exposition grounds more than a score of powerful electric searchlights, and in the exhibit made by the Navy Bureau of Equipment is to be found a small Curtis steam turbine of the type and size used on board ship. Here also this company is exhibiting its new electric fire-room timing device.

Wire Inspection.

After several conferences between joint Committee formed by representatives of the insurance interest and the Advisory Committee of the Flexible Cord Manufacturers, it was deemed advisable to devise ways and means of testing all flexible cord, both pendant and portable, manufactured under the rules of the National Board of Fire Underwriters, as recommended by the Underwriters' National Electrical Association. This to restrict the introduction into commercial use of any cord which would prove inferior to the N. E. Code standard, so as to protect reliable manufacturers against inferior goods, in competition.

Specifications for these factory tests have been drawn up by the above Committee and are as follows:

"Each coil of duplex cord shall be tested dry by the application of 1,500 volts alternating current, simultaneously to each of the two conductors; contact being made on bare copper wires at either end of the coil, and care being taken that the other ends of the conductors do not come together. Alternating current to be supplied from a transformer with an actual working capacity of at least 5 kilowatts."

These factory tests will be conducted in a similar manner to those now carried on under directions

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of the W. I. B., in the manufacture of N. E. Code rubber covered wire.

Stamps similar to the attached sample, will be issued by the Wire Inspection Bureau and sold to the different manufacturers at a charge of 2½c. per thousand running feet of cord tested. These stamps to be attached to the coils of tested cord by the manufacturers themselves, and to serve as a guarantee that cord so stamped has successfully withstood the tests specified by the Bureau. They will be furnished for 250 foot, 500 foot, and 1,000 foot coils, as desired.

The majority of flexible cord manufacturers have recently agreed that, on and after March 1st, 1907, all National Code cord manufactured by their companies will be made up under the new specifications and duly tested, and will bear identification mark of the W. I. B.

It is understood that a reasonable time will be allowed, after this date, for the disposal of Code cord not bearing the stamp of approval of the Wire Inspection Bureau, on all such cord manufactured before March 1, 1907, and with this understanding the April List of Electrical Fittings will contain the names of Flexible Cord Manufacturers agreeing to the tests of the Wire Inspection Bureau and using stamps as guarantee that these tests have been properly made.

No cord will be considered as having been tested which does not carry an identification stamp. Stamps to be securely fastened to the shipping tags attached to the coils.

Mr. Guy V. Williams, for several years New York manager of the Bryan-Marsh Company, and until recently connected with the sales department of the Westinghouse Electric Lamp Company, has opened offices in the Victoria Building, St. Louis, Mo., under the firm name of Guy V. Williams Company, commercial engineers and sales agents.

The purpose of the new company is to afford manufacturers of electrical apparatus and supplies expert representation, and to act as general sales agents, marketing the entire output, or acting as their local sales agents in the city of St. Louis and surrounding territory. This service is to be given to these manufacturers who wish to establish, through the above firm, the equivalent of their office in that territory. The members of the firm have had a wide and successful experience in this field, which they intend making a specialty, and this paper cannot recommend too strongly the service of this firm to manufacturers who are not already profitably represented in their territory.

An alternating current fan motor is now being placed on the market by the Western Electric Company, which bids fair to be a great success. Heretofore the principal method of operating fans by alternating current has been by what is called the induction motor. The induction motor, however, has always had one great drawback, and that is its uncertainty in starting immediately when the current is turned on. The reason for this trouble has been due to the simple fact that while most of the lighting and power companies furnish alternating current, it is nearly all what is known as single phase, and the ordinary induction fan motor will not run properly until it gets up to the proper speed. The starting torque is so small that it requires several spasmodic revolutions of the armature before the steady speed is obtained. The Western Electric's new A. C. Fan Motor does entirely away with this trouble by using a specially constructed commutator. They guarantee this motor to positively start when the current is turned on, because it does not operate on the induction principle, but in the same way as the regular series direct-current fan motor.

Another great advantage of this motor is its "Universal" feature, which allows it to be used either as a desk or bracket fan, and the change from one to the other can be made in a minute. They call it the "Two-in-One" type, because it really makes one type of fan serve two purposes. An ingenious diagonal joint in the standard makes this change possible and a glance at the illustrations will make this clear.

All the working parts of the motor are completely enclosed, so that it is impossible to clog up the machinery with dust or dirt.

From a mechanical standpoint the blades are great savers of current, the angles at which they are built following along specially designed lines, thereby furnishing maximum breeze with minimum current consumption.

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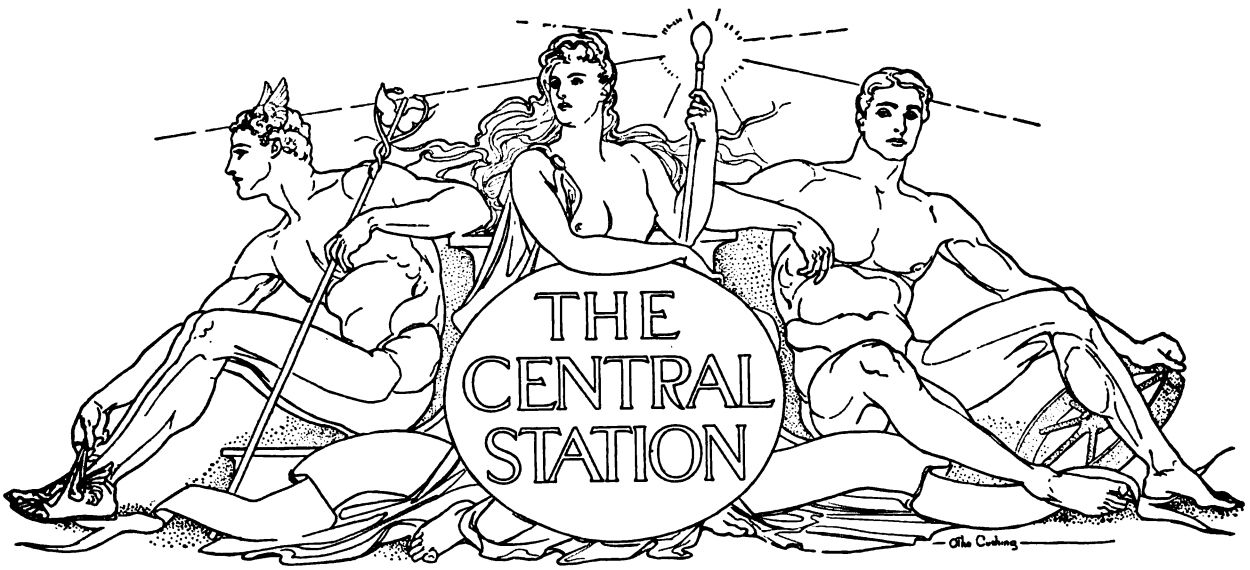

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

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Central Station Light, Heat and Power Principles

BY NEWTON HARRISON.

Construction and Its Financial Basis. The unlimited expenditure of money in the construction of a station, may be the means of securing an unusual efficiency. But the investment in this case would probably call for such large earnings, in order to pay the legitimate interest charges, that a financial solution of the problem proves to be impossible. The idea presented, is that of a large sum being spent on a power or central station, but whose earnings, whatever the extent of the investment, are limited. In other words, if one hundred thousand dollars spent on a plant will give a certain commercial efficiency, and to gain a few extra per cent. in this direction fifty thousand dollars more are spent, then it is readily seen, that the earnings being the same for the greater as well as the smaller investment, the interest charges are fifty per cent. higher for one than the other.

It is, therefore, necessary in the construction of stations built for the generation of electricity, that the investment be so limited that, the interest on it will not forbid the possibility of financial advantage arising from the earnings. The moral of this is true of any other form of financial investment of an industrial order. To gain a higher commercial efficiency, it does not pay to invest money all out of proportion to the earnings. If a district canvassed for lighting yields an income of fifty thousand dollars a year, it is obvious that a million dollar investment would not pay, and it is a question as to whether even a half-million dollar investment would pay. In other words, in addition to the fixed interest charges on the cash investment, generally amounting to thousands of dollars a year, are the running expenses, without considering the charges for depreciation and the profits. The various elements to be considered, therefore, in connection with an installation having for its object the sale of electricity, when itemized, present a simple basis for financial analysis.

Items Considered in Station Construction and Operation. By keeping clearly in mind the points to be considered in the design and construction of a station, a financial solution of the problem of investment and profits may be obtained. The items may be presented as follows:

First: The capital to be invested for a ground site and the building with its necessary engineering ap-

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pliances. This sum must be made to pay its own interest charges at six per cent. per annum.

Second: The weekly, monthly and annual charges, consisting in total of the yearly pay roll, must be obtained from the business of the station without question as to the certainty of its production.

Third: The item of depreciation must be considered, and the money to pay for it, whatever the rate of allowance per annum obtained from the annual earnings, as in the previous cases cited.

Fourth: The last and by far not the least of the items to be considered with respect to the annual earnings, is the annual profit. This may be any percentage of the total investment, but it is not supposed to fall below five or six per cent., otherwise the financial end has not proven successful. In other words, the investment of a large sum of money with its consequent cares and attendant risks, is not worth while making, unless there is absolute assurance in advance, of returns which are unquestionable.

The effort to finance an institution of this kind, by forcing its earnings to meet all these expenses, frequently leads to dangerous experiments. When all charges are paid but that which constitutes the earned increment, it may be found that this does not represent the proper percentage of the invested capital. If this is the case in general, it is an evidence of a bad investment or a poor system of management. If it is neither of these, but is inherent, remedies will be difficult to find, unless the earnings can be sufficiently increased without a greater investment to make the plant pay.

Station Repairs. City plants have an advantage over those situated in the country, or where the population is somewhat scattered. In the case of the city plant, the wires are probably underground, and though severe storms sweep over that section little or no damage is done. But in localities where the winds blow severely, and snow and rain fall in abundance, the risks of injury are proportionately increased. In other words, the repair bill of stations, considered annually, is more or less a record of the misfortunes the station has suffered from. This repair bill may include items of depreciation which arise solely from the natural wear and tear of the machinery and devices installed. On the other hand, the repair bill may be unusually high, because of the poor grade or complicated character of the apparatus purchased. These instances are obviously marked occasions, for the reason that they show how necessary the need is for the highest professional advice during the period of the station's design.

The idea that the investment must be kept down to its lowest terms, is apt to be misunderstood or at least misapplied, with the result that instead of an excessive outlay being made, an abnormal economy with regard to the investment is practiced. Though there is such a thing as the lavish expenditure of money in station equipment, there is also the converse to be considered, namely: poor judgment in the purchasing of apparatus, through which the bills per annum for repairs amount to a heavier sum total than was anticipated. A short-sighted policy like this shows clearly that the interest on the investment plus the annual charges for repairs, are greater than (the interest on the investment plus the annual charges for repairs) where the original investment was heavier.

Future Business Governing the Investment. The purchase of land, machinery and appliances must be made with an eye to the future of the business. It sometimes happens that the original outlay seems disproportionately large in comparison with the earnings. This is not necessarily a reason for either discomfiture or discouragement. One of the influences which must exercise a powerful effect upon the engineer designing a central station is that of the estimated future business. It is readily seen that a limited amount of ground, on which a building is erected containing machinery of very limited capacity, may prove to be an error, particularly if an institution of this kind is sufficiently stimulating to the community to give rise to a strong desire for electric light and power. In some communities, a plant of limited proportions becomes a large station only very slowly. In other communities, seemingly sluggish to respond, intense interest may be awakened very rapidly, and in consequence the lighting and power contracts may pile in so quickly that the manager and the financial supporters find it more than embarrassing to meet these new requirements.

On account of this, it is the general practice to leave a margin for increases in the way of extra lands, extra station space within the building, and perhaps extra machinery, in order to meet the increasing load. On this basis, therefore, an estimation of the exact value of the investment, which will constitute the correct estimation for a central station, calls for experience, knowledge, and considerable skill in drawing conclusions as to the probable outcome of the enterprise. The first few years in the history of a new station may indicate unusual financial pressure, due not only to the cost of ob-

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taining new contracts, but the expenses incident to the establishment of services to each building using current. In New York City, several millions of dollars have been spent in copper which is buried underground, to perform a service in distributing electricity to the various customers dependent upon the New York Edison Company for light, heat and power.

Station Items to Be Considered. The items to be considered in connection with a projected central station may be tabulated for convenience in the following manner:

(1) If the station is large, the position it will occupy with respect to the sub-stations acting as its secondary distributors.

(2) The particular system of transmission and distribution to be employed.

(3) The kind of generators, and the particular appliances to be installed for use in connection with them.

(4) The kind of steam plant, including the boilers, engines, pumps, condensers, etc.

(5) The business system to prevail with regard to the charging for power.

(6) The kind of station records that are to be kept for reference in the future.

These and other items, will provide a general idea of the conditions governing the choice of machinery and methods in the design of a station. It must be understood that all these considerations, contribute individually and collectively to the ultimate purpose held in view, namely: that of operating the station along such lines, that a reasonable annual profit is assured. In this respect, it may be stated, that the method of charging for current is one on which a great deal will depend. State jurisdiction, as well as municipal standards, have to a certain extent restricted the charges, and, therefore, the only outlet for the station manager, is that of making each customer willing to use more current, through the convenience and advantage it affords. In many instances this demand arises through natural influences, as station records will show.

Position of the Central Station. With the realization that a central station only differs from a business house, in the sense that it employs a different form of mechanism, it is now fully realized, that it, in common with other business institutions, must be mapped out with an eye to the ultimate profit in sight. For this reason, it cannot pay to install a central station in such a place, that the cost for water, for fuel, and for labor are so great, that the question of the enterprise proving successful is answered in the negative. If a station can be so installed, it must be built as near to the water as possible; for by this practice water and fuel are made more accessible, and in consequence the cost of operation proportionately diminished, and the possible profits correspondingly increased. On general principles, a station's nearness to a navigable stream is an advantage, otherwise if the topographical conditions render this impossible, the necessity of being near a railway terminus, or at least some point which increases the ease of obtaining fuel, is obvious.

Governing Influences in Station Construction. While the station is undergoing consideration in a financial sense, it is necessary to consider certain other items relating to the supplies of fuel and water, the degree of accessibility, the possibilities of future business, and the general character of the community to be served. Before presenting these features systematically, some consideration must be given to the question of the permanence of the community. Instances exist of "mushroom" towns not only on the site of gold mines, but in localities where certain industries once flourished, flickered and went out of being, with the subsequent disintegration of the community as a whole. A careful canvass must be made in order to avoid any serious investment of money in such neighborhoods.

It is, therefore, necessary to consider the items noted as follows:

(1) The best position the station can occupy, so that either train or water service is convenient to it.

(2) The ease and cheapness with which fuel can be obtained, and stored away for future contingencies or for constant use.

(3) The character of the water supply; due attention being paid to its chemical constituents. If very limy, the need arising for a system of water purification or condensation, to reduce the elements of injury and expense, with respect to the boilers.

(4) Whether the cost of ground is such that it will pay to have conveniences in the way of cheap fuel, good water, and easy access to the station, and yet find it necessary in order to gain these ends, to invest a large sum of money in expensive real estate. This problem is apt to be presented more frequently in cities, than otherwise.

(5) With regard to a building site near the water or on recovered ground, whether foundations can be so laid as to insure the durability of the station without risk from river or lake overflows, during the spring season.

(6) If dependence is placed on water-power, it

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is necessary to know absolutely in advance, whether that power is sufficiently reliable to be on tap, at a certain average minimum during the year. If the stream or river is apt to freeze and reduce the power to a low basis, it is necessary to know whether the amount of power will be sufficiently great to supply the needs of all customers, otherwise a supplementary steam plant must be installed to tide over this difficulty.

(7) Ease of getting labor at reasonable rates is of such importance, that unless this is possible, an unusually large pay roll will result, having a tendency to partly or wholly consume the profits of the enterprise.

(8) A knowledge of whether the community is regarded as one that is growing or not, may be a means of controlling any tendency to great expenditure. It is recognized that, advice to the contrary will mean an escape from possible financial embarrassments, unless the community represents a standard of wealth, possessed by those who established themselves in that locality and own comfortable homes.

There is such a thing as entering a community more or less opposed to innovations, and developing an interest in electricity sufficiently great, to form a good business foundation for the future sale of current. On the other hand, restrictions concerning smoke and noise may be such, as to forbid any progress whatsoever. Objections to industrial enterprises have always existed in residential districts, and for that reason, a central station far removed, may establish an extension by means of a high pressure system, leading to a small sub-station in such a neighborhood.

Boilers and Engines. The choice of the boilers and engines is one which must be made with great discretion by those intrusted with the responsibility. The steam turbine and gas engine have been establishing themselves with great rapidity in central station practice, but as yet steam is the dominant element in central station practice throughout the United States. It is, therefore, necessary to choose engines and boilers with respect to the service they are to perform, as well as with regard to the financial limitation imposed by the amount to be invested in total. Boilers must be chosen according to the following conditions:

(1) Efficiency.
(2) Cost.
(3) Depreciation.
(4) Floor space.
(5) Ease of cleaning.

The boilers of any plant must be readily accessible for cleaning purposes, and of such a construction, that little or no danger exists, of constant breakdowns. Imperfect boilers may curtail the capacity of a plant to such an extent, that it may prove a failure through loss of customers from bad service. On the other hand, boilers that are wasteful of fuel, may heap up expense to such a degree, that excessive charges arise through fuel consumption. A point of great importance in boilers, is the speed with which they can be fired and generate steam. The elements to be considered are, therefore, really three: the time of steam making, the efficiency, and the rate of deterioration.

Choice of Engines. The engines chosen for central station work must necessarily be reliable, efficient, and reasonable in cost for repairs. Considerations regarding them may be given as follows:

(1) Efficiency.
(2) Durability.
(3) Floor space.
(4) High or low speed.
(5) Rate of depreciation.
(6) Oil consumption.
(7) Regulation.

These and other items, constitute the rational considerations entertained with regard to an equipment of prime movers. The engine which lasts the longest, is naturally of the low-speed type. These when built of the upright form or marine type, occupy little floor space. Where floor space is not an important object, the horizontal engines may prove the best to install. Boilers and engines are so placed with respect to each other, that when the number of boilers is sufficiently great, they represent what are called "batteries." The boilers must be able to supply steam to one or all of the engines without any great intermediate loss. In other words, their position with respect to each other must eliminate condensation as far as possible, and yet not cause a waste of floor space.

Engines may be considered with respect to their appliances for condensation as follows:

(1) Simple condensing engines.
(2) Simple non-condensing engines.
(3) Compound condensing engines.
(4) Compound non-condensing engines.

The pounds of steam consumed per horse-power hour vary greatly with each style of engine. The so-called units of central stations, consist of an engine and dynamo direct connected, and the output of power, as electricity from the generator, may

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cost more or less, depending upon the pounds of steam consumed per horse-power hour by the engine. Other things being equal, it is readily evident, that the number of pounds of fuel consumed per horse-power hour in the boiler, and the number of pounds of steam consumed in the engine, are matters of great importance to the expert. If the fuel and boilers are bad, the pounds of coal consumed will be high for each unit of power. If the boiler is good and the fuel bad, the same will be very nearly true. On the other hand, it is as likely that the engine may be deficient, in which case, the waste of power will be in evidence also. It has been estimated, that the number of pounds of coal per horse-power hour, should not exceed from three to six pounds, but like all statistical records, conditions play their part in governing results obtained. A carefully selected boiler and engine, with a fair grade of fuel will give average results. No dynamos of less than ninety per cent. efficiency are sold in large sizes. Efficiency at the electrical end is absolutely assured. The responsibility for fuel and power efficiency, seems to rest largely on the shoulders of the mechanical engineer.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability of Telegraph or Telephone Company for Injury to Electric Company Employe from Current Through Telephone or Telegraph Wire from Electric Light Line.

"An unused telegraph wire, which it was alleged belonged to the defendant or was under its control, fell across an electric light feed wire of the Northern Electric Light Company. The telegraph wire had been connected with a call box which had been removed some months before the accident. The wire had fallen three or four weeks before. One end of it extended down so near the pavement that children reached and played with it. The other end was wrapped around an iron pole. The deceased was a trimmer in the employ of the electric light company, and was killed by an electric shock while engaged in placing carbons in a lamp attached to the pole. A reversal of the judgment for the plaintiff is asked on the grounds (1) that there was no sufficient evidence that the telegraph wire belonged to the defendant or was under its control; (2) that the falling of the wire was not the proximate cause of the accident; (3) that the presence of the wire and the danger because of its contact with the electric light wire must have been known to the deceased as he ascended the pole.

"That the wire was controlled by the defendant was not questioned at the trial, and, while there was no direct proof of its ownership, there was proof that it had been connected with a Western Union call box, and the defendant put in evidence a blue print, made the day after the accident, on which the wire was marked 'W. U. Telegraph Wire.' This by way of admission, supplied any defect in the formal proof of ownership. There was evidence that children had been pulling on the loose end of the telegraph wire, and that the electric light wire on which it rested had sagged, and there were burned marks on the frame of the lamp. Sparks had been emitted by the telegraph wire two weeks before the accident. Two theories of the cause of the accident were advanced at the trial. That of the plaintiff was that the deceased came in contact with the telegraph wire, which had been charged by its contact with the electric light wire; that of the defendant, that he came in contact with the frame of the lamp which was charged from the electric wire which had been pulled down and brought in contact with it. If the latter theory were correct, it would not follow that the defendant was relieved of responsibility, because it was its wire that either caused the sagging of the electric light wire by dragging it down

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or was the means by which children drew it down. The latter was a consequence to be foreseen and guarded against, and it did not break the causal connection between the defendant's negligence and the injury. A negligent act may be the proximate cause of an injury, although not the sole nor immediate cause, where the intervening act is set in motion or induced by the negligent act, and the consequence is one that should have been foreseen. In Marsh v. Gils, 211 Pa. 17, 60, Atl. 315, relied on by the appellant, the injury to the plaintiff was caused by the unrelated act of a third party, and was not a probable consequence of the defendant's wrongful act." Dannenhower v. Western Union Telegraph Co. (Pa.) 67 Atl. Rep. 207.

SAME SUBJECT—USE OF GLOVES.

Plaintiff's intestate was sent up a pole to repair a burned out fuse box. Upon the same pole was a converter below the fuse box. A guy wire ran from the pole to support a trolley wire. High tension electric wires and low tension electric wires, including a feed wire for an electric railroad company were also supported by the pole. The question of negligence arose from the presence of the guy wire near the pole and the claim was that as soon as the deceased took hold of one of the wires of the company for which he was working, he slipped and came in contact with the guy wire which supported the service wire of the electric railway company by a piece of scrap wire; that in trying to prevent himself from falling, his spurs having broken out of the pole, a circuit was formed with his body and the guy wire. A portion of the opinion reads as follows:

"The chief contention of appellant with reference to contributory negligence is that the deceased should have worn rubber gloves, which were provided by his employer for handling wires charged with a dangerous voltage. The testimony for plaintiff tended to show a custom among the employees not to use such gloves in cold weather, as they prevented the men from using their hands effectively, and that it was regarded as proper to work without gloves, unless they were working on a 'bad pole.' We think that we would not be justified in saying under the evidence that it was conclusively negligent on the part of the deceased to work where he was working, depending on the insulation afforded by the dry pole, without wearing such gloves. If, as in the case of Junior v. Missouri Electric Light & Power Co., 29 S. W. 988, 127 Mo. 79, it appeared that the employee had undertaken to handle live wires through which a current would pass from one to the other, it might well be said to be conclusively negligent in him to omit to use insulating gloves. And the same explanation is applicable to Hart v. Allegheny County Light Co., 50 Atl. 1010, 201 Pa. 234. But the theory of the plaintiff here is that deceased was not handling at the same time two live wires, but only one, and that the insulation of the pole on which he was supported would have given him sufficient protection had he not by accidentally slipping brought his foot in contact with an uninsulated wire, the danger of which was not known to him, because he had no reason to know that it was not grounded. The case falls, therefore, within the principle announced in Knowlton v. Des Moines Edison Electric Light Co., 117 Iowa, 451, 459, 90 N. W. 818. In Wagner v. Portland, 67 Pac. 300, 40 Or. 389, the question was not as to whether the employee was conclusively negligent in not wearing gloves, but as to whether the employer was not negligent in failing to furnish such gloves. In this conectinon complaint is made of an instruction in which the jurors were told that they might consider, on the question of contributory negligence, a custom and usage by the employees of the Des Moines Edison Light Company, which had prevailed for a long time, and which was known to that company, not to wear gloves except in wet weather. The knowledge of such a custom on the part of the light company would have no bearing on the question whether deceased was guilty of contributory negligence, so as to defeat a recovery against this defendant. Such a custom or usage is of importance only where it is contended that there is contributory negligence on the part of the employees in disobeying the rules of the employer. Under such circumstances, it is competent to show by evidence of a custom known to the employer not to conform to such rules that they have been in effect waived. So far as this defendant was concerned, it is wholly immaterial what were the rules of the light company, or whether such rules had been waived by it. In the same instruction the court left it to the jury to say whether the deceased was handling live wires of the Des Moines Edison Light Company charged heavily with currents of electricity, although there was not the slightest conflict in the evidence as to his having come to his death by reason of doing so. The court seems also to have left it to the jury to say whether deceased did in fact wear rubber gloves, although it is conclusively shown that he did not do so. The instruction was erroneous and prejudicial." Snyder v. Mutual Telephone Co. (Ia.) 112 N. W. Rep. 776.

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Electric Lighting and Power Companies—Liability for Death or Injury from Electric Current

The liability of an electric lighting and power company for death or injury from an electric current is a department of the law and it effects central stations which has many examples in decided cases and which has involved an almost endless amount of litigation. This question of legal liability rests upon a well-known rule of law that one who injures his neighbor must respond in damages for the injury, and this liability is the same whether the cause of the injury be a locomotive or an electric current. The danger arising from the electric current is greater and the rule as to protection is correspondingly increased because of the fact that the danger is not apparent. A copper wire carrying a current of enormous voltage is a harmless looking thing and does not betray to the observer any evidence of the great danger which lies latent therein, as does the locomotive or buzz saw or piece of machinery which may cause an injury. It goes without saying that a vast amount of litigation has grown out of the efforts of a certain class of attorneys who supply themselves with practice by soliciting personal injury cases. Reprehensible as this practice is in principle and frowned upon by the great mass of the profession as it is, nevertheless it has had the effect of stimulating the care taking ideas of central station managers, of boards of directors and general managers of power companies, to prevent this harmless looking strand of metal from becoming the source of injury and possible death to the ignorant. In this connection it must also be borne in mind that it is only men of average intelligence whom the light or power company is obliged to look out for the safety of so far as the adult is concerned, and it is not sufficient that they shall have cared for the safety and have looked out in advance for the protection of men of superior intelligence or education. This matter of average intelligence or average care on the part of the individual in the hands of a jury with natural predilections in favor of the plaintiff becomes a serious menace and requires the electric light and power company to protect a class in the community who are below the average in intelligence and has resulted in lowering the plane or standard required to measure what is due care on the part of the one injured. The electric lighting companies are generally immune because of the fact that their powerful currents are conducted on cables running at great distance from the ground on poles protected at crossings by cradles from falling upon wires of other wire line companies, and where brought in contact with buildings or when near enough to the ground to be within reach are protected by a rubber covering effectually preventing the establishment of a connection by the touching of the wire. This, coupled with the fact that in the cities these wire lines are generally required to be placed under ground out of reach of the average pedestrian, has reduced to the minimum the danger and has very greatly lowered the rate of injuries or deaths resulting from contact with conductors.

So great, however, has been the development in the supply and use of electrical energy, that many cases arise still involving injuries to persons or property from contact with electric currents. These injuries arise so far as persons are concerned in three general classes of cases. The first of these classes and by far the most important one are cases of injuries to the great general public who have no relations with the electric lighting and power company but who accidentally come in contact with the current. As to these the general rule of law requires the central station to exercise the care of an ordinarily prudent man toward those who may come in contact with its wire lines and renders it liable for injuries only in the event that it shall have failed to exercise due care, such as would be used by an ordinarily prudent man under the circumstances and when, because of such failure one who was himself exercising due care for his own safety comes in contact with the current and is killed or injured.

Another class consists of those persons who purchase the electric current from the company and who are injured in their own home while using the current, exercising due care for their own safety under the circumstances, and when so injured the company becomes liable, as the law imposes a much higher degree of care than in the other case. The first class is also modified by the fact that in many States the company is not liable if the person injured is not upon his own premises or upon premises where he has a right to be, except that in the case of children, this is the general rule. In the case of children the company is required to guard against them without the corresponding expectation that the child will exercise due care for his own safety. The only other safeguard is the obligation of the parents which, as will become manifest later on, is very slight.

The third grade class of cases consists of injuries to employees of the Central Station Company resulting in their injury or death. As to these the company owes the duty of furnishing them with a

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safe place in which to work a safe fellow-servant and experienced foremen. It also is required to warn and instruct such servants of the deadly nature of the substance which they are required to handle and of the methods used to guard against death or injury from contact with it. Having done these things, the company is not liable except in States where employer's liability acts have been passed for injuries or death resulting from contact with the current, if the risk was one which the servant may be considered as having assumed in accepting the employment, or if it was one caused by the negligence of a fellow servant, or of the servant himself, and this is true whether he was warned and instructed or not and whether the place was safe or not, if he had sufficient intelligence in the premises to appreciate the danger, if the servant himself contributed to the injury complained of.

Kern River Plant No. 1, of the Edison Electric Company, Los Angeles, Cal.

The past few weeks have witnessed the completion of an engineering project whose influence on Pacific Coast development, especially that of Southern California, can hardly be over-estimated. Kern River Station No. 1 of the Edison Electric Company, of Los Angeles, has been placed in operation. This plant, from which is developed enough power to double the capacity of all the Edison Company's other plants combined, is located far up in the lower Sierras of California, almost at the head waters of the Kern River; whence, through a wonderful channel, comprising twenty tunnels in all, water is led down 12 miles from the mountains for a fall of nearly a thousand feet and hurled against the four great Allis-Chalmers Impulse wheels, aggregating over 40,000-h.p. and direct-connected to electric generators, with which the plant is equipped.

The engineering problems involved in building tunnels, flumes, penstocks and power houses to endure the heavy strains put upon them, were no more difficult to solve than the transmission of the electrical output from the new station under a pressure of 75,000 volts over a distance of 117 miles to Los Angeles. The route of transmission lies through the canyon in a direct line, thence over the hills, plains and divide, to follow the course of the Piru River and its tributaries. Large galvanized iron towers carry the heavy wire cables of the transmission line.

In many respects the Kern River development is unique. It is claimed to be the largest hydraulic electric plant west of Niagara. The transmission line is one of the longest in the world. The pressure of 75,000 volts over such a length of cable is the highest ever attempted. The conduit which leads to the pressure main is the longest underground tunnel system in use for this purpose. The concrete encased penstock, tapering so as to accelerate the force of the water at the power house, is said to be the first of its kind ever placed in service.

The four big wheels which convert hydraulic to electrical energy, were built by Allis-Chalmers Company, of Milwaukee, and have each a capacity of 10,750-h.p. at full gate and a speed of 250 R. P. M., when operating under a net effective load of 365 ft. In addition to the main turbines, there are two exciter turbines, also of Allis-Chalmers design, each with a capacity of 450-h.p., and a speed of 430 R. P. M.

The generator (turbine) units are of the impulse type, with hand adjustable needles and governor-operated deflecting nozzles. Each unit has two runners, one on either end of the generator shaft. The interchangeable buckets are made of non-corrosive phosphor bronze of special mixture for the high head and are attached to the cast-steel discs bolted to the flanged ends of generator shaft. These discs of cast-steel furnish sufficient fly-wheel effect to supplement the amount contained in the generator, in order to meet the guarantees of speed regulation. (For sudden changes of load amounting to 25%, 50% and 100%, it is guaranteed that the speed variations will not exceed 1.7%, 3.5% and 7.8% respectively.)

The nozzles are provided with hand adjustable needle and arranged to be deflected by the governor automatically, or by the latter's hand-regulating device. By deflecting the jet, instead of regulating its discharge by adjusting the needle with the governor, it is possible to secure a constant velocity of water in the pipe-line, as well as a constant discharge of water into the tailrace, even when the plant is operating with heavy fluctuations of the commercial load.

The nozzles are of the best quality of cast-steel. Special attention may here be called to the design, which has a number of new features. The nozzles consist of two "Y" pipes, flanged together in such a way that the whole nozzle has a diamond shape. The up-stream end of the nozzles forms the movable part of the knuckle joint and the down-stream end carries the nozzle tip. By making the nozzles dia-

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mond shaped, the following advantages are obtained:

1. The center of the jet corresponds to the center of inlet pipe; therefore, any reaction from the jet upon the needle and nozzle is not eccentric. This is of importance with deflecting nozzles, where any variable reaction upon the governor should be avoided.

2. As the two branches of the "Y" join at ample distance from nozzle tip, the water has time to gather concentrically around the needle under an absolutely uniform pressure. The result is that the jet leaves the nozzle tip at a high velocity and without disturbance.

3. Due to the fact that the jet leaves the nozzle tip uniformly, the needle is axially balanced and not subject to any vibration.

4. The needle stem not being subject to any bending, it need not be made slender and flexible, but is made very substantial. The end of the stem projecting through the front "Y" pipe is of smaller diameter than the stem. The differential room thus formed can be put under adjustable water pressure. This pressure tends to close the needle and puts all pins and links of the connection in a position for hand adjustment under slight pressure in the closing direction. By this, any rattling of the needle is prevented.

The upstream end of the nozzle forming the movable part of the knuckle joint is hooked into the stationary part, or swivel-head. The swivel-head is heavily bolted to the foundation, as it has to take up the full pressure of 375,000 lbs., tending to pull the nozzle away downstream. This pressure is taken up by two steel pins carefully fitted into their bearings and provided with suitable lubrication.

A 28" gate valve is connected to the swivel-head, and controlled either by hand or electrically by a motor operated from the switchboard. All parts of this gate subject to the operating pressure are made of the best quality of cast-steel. The gate is single seated and bronze lined.

The needle consists of a hollow stem of cast-steel, into which is screwed and secured the steel needle tip. A heavy cast-iron base plate, grouted and rigidly bolted to each side of the generator base frame, forms the solid foundation for the cast-iron wheel housing. These housings are made very substantial in order to avoid resounding. They are divided horizontally along the center line of shaft, thus altensions of removable steel plates which protect the of the buckets. The sides of the housing have exlowing easy removal for inspection or for replacing concrete against the impact of the discharging water. The pits in which the deflecting nozzles are located are of sufficient width to allow passage on either side. They are covered with substantial cast-iron floor plates, made in sections of such size as to permit of easy removal.

Another feature of these impulse wheels deserves comment on account of its novelty. As already mentioned, the regulation of the wheels is effected by a governor which deflects the jets of the two nozzles. The needles are adjusted by hand and are usually set to that maximum size of jet which will be sufficient to develop the maximum peak load expected for that period of setting of the needles. In other words, there is always a maximum amount of water leaving the nozzles. The governor adjusts the deflecting nozzle in such a way that only as much water is directed upon the buckets as is needed for the load for the time being. The balance discharges below the buckets into the tailrace. It is evident that, at times, when all load is thrown off the wheels, the governor will deflect the jets entirely. Each jet has a maximum diameter of 7⅜" and leaves the nozzle tip at a velocity exceeding 225 feet per second. It was, therefore, necessary to provide means of receiving this tremendous power and deflect the jet into the tailrace in such a way that its impact would not be detrimental to the parts against which it is directed. This has been successfully accomplished by the present arrangement of deflectors. It consists of an upper channel heavily ribbed and bolted to the concrete foundation, and of a lower bottom plate. The channel at its upper end is slightly more inclined than the deflected jet. Thus the jet will strike the bottom of the channel under a small angle and, therefore, tend to spread and fill the section of channel. The channel gradually widens and, consequently, the jet is offered a larger resistance area. The lower part of the channel is curved and at its end the jet discharges almost perpendicularly. The bottom plate is "S" shaped, its upper end being flush with the botom of the wheel pit, the lower end being practically level. The jet strikes the bottom plate almost in the turn of the "S" and under a small angle. Thus the jet is again forced to spread and follow the base of bottom plate. In due consideration of the unavoidable wear and tear of these deflectors, they are lined with removable steel plates wherever the surfaces are exposed to the flow of the deflected jet.

The exciter units are also of the impulse type, with hand adjustable needles and governor-operated deflecting hoods. Each unit has one runner over-

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hung on one end of exciter shaft, the other end carrying a fly-wheel. The interchangeable buckets are bolted to a cast-steel disc, which is keyed upon the exciter shaft. This disc and the fly-wheel furnish sufficient fly-wheel effect for the speed regulation guaranteed. The nozzle is stationary and "S" shaped in the horizontal plan and carries the stand and hand wheel for hand operation of the needle. The needle has a removable tip. A hand-operated gate valve is connected to the upstream flange of the nozzle. The base of the wheel housing is cast in one piece with the exciter base frame. The cast-iron wheel housing is split horizontally along center line of shaft. The sides of the base have extensions of removable steel plates which protect the concrete against the impact of the discharging water. The pits of the nozzles are covered with removable cast-iron floor plates.

The automatic regulation is effected by a governor which deflects the jet from the buckets, this, however, not being accomplished by deflecting the whole nozzle, but simply by inserting a hood which cuts into the jet from underneath and directs this part of it directly into the tailrace. That part of the hood which deflects the jet is made of steel and is removable. Care is taken in designing this arrangement so that the knife edge of the hood does not disturb the working portion of the jet.

When the governor arrangement was designed, the leading idea was to have each turbine with its respective governor form an independent unit. Although the available operating water pressure of 370 lbs. from the force main is ample to operate governors, it was preferred to substitute oil pressure. This precaution is fully justified, as long years of experience in operating hydraulic governors has proven that the safety is rather questionable, and the wear and tear of the parts of regulating valves causes a constant expense for repairing and replacing parts, which necessitates shutting down the respective units. It was also preferable not to feed the governors with oil pressure from a control system, but to make each governor absolutely self-contained.

Special attention was paid to the safe operation of the units, avoiding from the beginning any runaway. For this purpose, the arrangement of the generator, as well as the exciter governor, was made in such a manner that the jets will be automatically deflected from the buckets should the oil pressure in the governor fail.

The weight of each generator deflecting nozzle is partly carried by a hydraulic balancing piston, which receives water pressure directly from the force main. As soon as the oil pressure in the governor fails, the nozzle will lower on account of the unbalanced weight, and thus deflect the jet from the buckets. The same result is accomplished with the deflecting hood of the exciter wheels, which is connected to a hydraulic water piston, tending always to insert the hood and thus deflect the jet.

The governors are driven by a silent chain from their respective wheel shafts. The connections between the operating pistons and the deflecting nozzles or hoods consist of levers, pins, links and shafts, and the use of gears or racks has been avoided, thereby preventing the jars that result in lost motion and wear and tear.

Attention may also be called to the fact that all constituent parts, as well as all accessories, are attached or combined with one main casing, the advantage in this being that each governor can be assembled and thoroughly tested where built, and shipped completely assembled to its final destination. The main casing contains the main operating cylinder with piston and mechanical hand regulating device. The oil pump is attached to the casing and immersed in the oil reservoir. It is of the rotary type, having no valves, which are often the cause of failure of oil pressure. The main pump shaft also carries the bevel gear which drives the fly-balls operating the pilot valve over the regulating lever. The pilot valve is self-contained between opposing pressures, and any reaction upon the fly-balls is eliminated. It is evident that this is a condition of prime importance for exact regulation. The pilot valve distributed the oil pressure in the regulating cylinder. The motion of the regulating piston is reversedly transmitted to the regulating valve by means of a combined compensation. The leverage of this compensation is adjustable, so that the governor may be set to any change of speed between no load and full load, from 16% to absolutely constant speed.

The governors are equipped with four regulating devices which can be used at any time, viz.:

1. Mechanical hand regulation (without oil pressure).

2. Automatic regulation with fly-balls.

3. Hand regulation with oil pressure (fly-balls disconnected by a clutch coupling inserted between pump shaft and fly-ball shaft.

4. Hand regulation with oil pressure and electric motor operated from the switchboard. (Synchronizing attachment.)

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Cost of Light Sources

Daylight has been estimated at something like a hundred and sixty candle-power per square yard, which averages up at the rate of eighteen candle-power per square foot. Any form of lighting giving results comparable to this, would be eminently successful as a competitor of daylight. The cost of such a system, however, might have the tendency to remove it from that class of practical efforts called commercial successes. It is not so much a question of getting light from different sources of illumination, as much as it is that of getting the public to pay for it. No central station would refuse to supply enormous candle-powers in the shape of incandescent or arc lamps, were they ordered by responsible parties. But they would consider it extraordinary were such an order given regardless of the cost.

A comparison of the costs of various systems of lighting have been given in an article by Mr. K. Edgecombe. On the basis of 1 being the cost of the Bastian mercury vapor, the following comparative figures occur for electricity or gas: Bastian mercury vapor 1, tantalum lamp 1.3, low pressure gas 1.35, Nernst lamp 1.6, high pressure gas 1.9, and a tantalum lamp in a Loftus lantern 2.3. The greatest cost is found in the case of the last lamp mentioned, a case presenting the effects of a special form of lantern of a material which absorbs the light.

This is a feature that cannot be ignored in connection with any form of electric lighting, where a certain quantity of light is desirable. Though consumers pay for the amount of electricity the lighting devices absorb, it is quite evident that they really desire to pay for light. It is known to some of them that light is a form of energy, which cannot pass through even transparent bodies, without a loss sufficiently great in some cases to cut down the original supply a heavy percentage.

If one hundred horse-power of electrical energy is sent into incandescent lamps, about ninety-seven horse-power of the total is necessarily degraded into heat in the carbon filaments of the lamps. The light obtained from the thousand or twelve hundred incandescent lamps, is really due to only three horse-power of the total amount of energy transmitted. Were the case varied, and arc lamps used instead, about ten horse-power of the original one hundred would be transformed into visible radiant energy. The cost of light in any instance, therefore, can be more or less evaluated, with respect to the method of transforming or degrading the energy from which it is to be derived. Light is so distinctively a form of energy, that it is difficult for the scientist to look upon it differently from any other form of force, from which he gains his experiences. In consequence of this, an electrical system consisting of the generating and conducting sections, is a transforming system.

First, chemical energy is transformed through the medium of the boiler and engine into mechanical energy, with a consequent loss, which deprives us of a large percentage of the original power. Then the mechanical energy absorbed and transformed by the dynamo, yields a lesser percentage still, and finally the electrical energy transmitted and degraded into heat, becomes transformed into

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two kinds of radiations: one, of the order of heat which absorb from ninety to ninety-seven per cent.; the other of light, which absorb from three to ten per cent. The cost of light sources, therefore, is entirely dependent not only upon the character of the transformations transpiring, but upon the number of them as well.

Though electricity is able to yield a better light from fuel or from its original derivative of power than any other form of energy employed, it is as yet obtainable commercially only after a series of expensive processes have contributed to its production. As has been repeatedly stated by the highest authorities, we are not yet in possession of the secrets by which we can create the particular form of ether waves required. The heat wave is a very long wave in comparison with even the longest of visible light waves. The cost of light is, therefore, in any instance, due to the involved method of getting the short visible wave. To get it, long waves are first produced, and these are made to yield the shorter visible wave. The transforming processes, therefore, are those in which one form of energy is turned into another, simply because that is the only way of ultimately obtaining the shorter light wave.

The consideration of these facts will undoubtedly lead to the conclusion that, the manufacture of light and the methods employed for the generation of electricity, are more closely related than have hitherto been realized. Though electricity finds its field of usefulness in the development of motive power perhaps to a greater extent to-day than it does as a source of light, it is, however, merging to the front so rapidly, that the day is not far distant when the amount of electrical energy used for one purpose will be nearly as great as that used for the other.

What sources of light actually cost is an interesting commercial question, whether those values be actually given or only relatively. The point of importance is not so much the detailed consideration, as the broader and more generalized view of the conditions and difficulties that have to be faced. At one leap the cost of light could be cut down fifty or seventy-five per cent., were man's power of invention great enough to discover a means of efficiently transforming ether waves. Until this is done, the cost of light sources can only be shaded a trifle at a time, by methods leading to a somewhat greater economy.

Closing Contracts for Current

Manufacturing electricity, so to speak, and selling it, is the function of the central station. If the contracts for current are sufficiently great to enable the station to run day and night at a constant load, the electricity will be generated more cheaply than if the load fluctuates between wide limits. Therefore, not only does the securing of contracts for current mean more profit for the station, but they also mean a more efficient operation of the machinery within the station, provided they are distributed in a manner which permits of a fairly uniform load. The closing of contracts for current is a business operation, the supplying of the current is an engineering operation, and the securing of uniformity in load by the distribution of the contracts, means economy in operation.

There is such a thing as an agent representing a central station, going out with the definite purpose of getting a contract for current to be consumed at certain hours of the day. Contracts of this description possess a dual nature; they yield profit in both directions. In the first place, the heaping up of contracts during the time of greatest load, means wear and tear, and additional expense beyond the ordinary. When the load is light, increases in current consumption greatly aid in securing that relief, to which every station manager looks forward; the raising of the load curve at one point, and if possible, its depression at another point.

These facts relate entirely to the condition pertaining to contracts secured during hours of light and heavy loads. At present, it is well recognized, that the hours of light load are that part of the day when people sleep. It is difficult, therefore, to discover or invent any means by which the current consumption at that time can be legitimately increased, and made to serve a useful purpose. Were electric heating in vogue, to the extent the future seems to have in store for it during the winter nights, at least the load would be increased and remain fairly uniform throughout the night. But house heating by electricity at present is limited, and as is natural, the consumption of current through lighting is at its minimum indoors. The only hope, therefore, of holding the load fairly uniform, would be due to some plan by which the street lighting would be increased in proportion to the emptiness of the highways themselves.

Though municipal aid rarely takes on the aspect of charity with respect to central stations, yet the possibility remains of the use of a far greater degree of illumination in the streets at night than has hitherto prevailed. The agent of the central station, whose business it is to get contracts for current, knows by practical experience, that contracts

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are more easily obtained during the rush hours of the station than for other times. He is frequently forced to answer questions which consume time and serve no useful purpose. But the occasion on which it is necessary for him to put forth his utmost efforts, is that of a business man considering the advantage of installing his own plant.

A business man's friends generally include one who poses as an engineering know-all. Frequently through subtle psychological influences, the business man is trapped by such well-meaning, though badly informed friends, and in consequence, acting on their advice individually or collectively, concludes that it is unwise to surrender the profit the central station would make, and, therefore, see a vision of his own plant producing electricity cheaply for him. Trying to be just to both sides of the case, it is nevertheless evident as a basic proposition in electrical engineering practice, that small plants, unless representing exceptional cases, will not pay. When badly managed large plants fail to make good, and the doubts are certainly not in favor of the business man.

The small store-keeper also represents a customer, whose opinions on electric lighting are often presented in the most picturesque language. His case is generally that, "of what his neighbors told him." The contract agent, therefore, has unique experiences in dealing with the suggestions of friends and the experiences of neighbors, among a certain class of possible consumers. In such instances he derives his greatest strength from a positiveness of knowledge, which ultimately overrides all the objections presented. The contracts he secures, are largely proportional to the amount of conviction with which he is able to persuade the hesitating and the uncertain who try the experiment of lighting by electricity, instead of oil or gas.

By laying out his work systematically, by classifying his possible customers, and by being so well informed and sufficiently ready in speech and argument to meet the demands upon him, an agent will meet with success in districts that have withstood canvasses for many months. The class of contracts that are most profitable to the central station are not necessarily the single large ones, for the reason that a group of small contracts sufficiently contiguous to meet with the requirements, other things being equal, will yield a greater profit. The temptation to very large current consumers to install their own plant must be met by the central station at such figures that the suggestion is dropped. In some cases the consumer has advantages which could not even be approximated were he the possessor of a plant. On the whole, the supplying of current from a given center, is not only natural and necessary with respect to the interests of commercial and private life, but it is rather a difficult matter to get electric lighting done reasonably, safely and satisfactorily by any other means. Though the agent getting the contract is performing a business function, the consumer is also brought in contact with advantages he eventually finds it difficult or impossible to relinquish.

The Expert on Illumination

It has always been noted, that with the inception of a new field of work, the need would arise for various kinds of experts, to give opinions relating directly and indirectly to the main idea. This is true in electric lighting, because of the varied departments that correlate in this field of work, and require supervision by competent men. There is the boiler, engine, dynamo, switchboard, and outside circuits; all of which supply their quota in the common effort to do electric lighting. But with these departments established, and each performing its function in a manner proving highly satisfactory, the problem of light distribution, which calls for a thoroughly analytical and synthetical mind to see through its difficulties.

The expert in illumination, therefore, has risen to importance particularly in electric light work, and it is his judgment that plays an important part in the laying out of a lighting system, not with respect to the station equipment, but most emphatically with respect to the centers of light and their most rational distribution. Judgment is a rare possession, so rare in fact, that what is called common sense is well known as uncommon sense. For this reason, a special training is necessary for those who enter the lighting field professionally, and whose main work is that of obviating what would otherwise be the evil consequences noted in bad lighting, due to a lack of judgment on the part of the consumer.

The expert in illumination consequently has his work cut out for him. Of this there is little doubt when it comes to the case of a theater, auditorium or house of worship; and it is not any less true where house lighting or street lighting calls for special consideration. The right light in the house means a saving of eyesight, and the right light out of doors means less crime and certainly more convenience. The larger places to be lit, including big

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stores, call for a thorough scientific knowledge, or the light problem as solved by the so-called expert will be a fizzle. The expert then, to live up to his reputation, must be able to cover the ground thoroughly, not only from the standpoint of arbitrary judgment, but that of absolute certainty. On this basis alone the amount and character of the illumination can be correctly estimated, and a form of satisfaction given that becomes entirely authoritative.

Estimates vary with respect to the candle-power required for the lighting of a given space. As a general rule places must be so well lit that the reading of ordinary type is accomplished without eye-strain. Avoidance of gloom which is the inevitable result of bad judgment in lighting, is so necessary, that unless the lighting is thus done, the audience in the case of a theater for instance, is psychologically unfit for the rendition of the play, unless it happens to partake of a gloomy character. With the assumption that lighting in the majority of cases must be done so that reading is easy, some fundamental basis can be secured relating to the degree of illumination or candle-power per unit of area.

Now the expert on illumination knows this; that is to say, he is perfectly well aware that every square foot of floor must have a certain amount of light falling upon it, in order to fulfil the necessary conditions; and he knows as well that the further away the source of light from the area to be lighted, the less the candle-power found there per unit of area. It is the business of the light expert therefore, to see that there is neither too much light, which would constitute a waste, nor too little light, which would constitute an error. Text-book information varies in this respect, though sixteen candle-power for the lighting of from twenty-five to fifty square feet of floor space may be noted. On this basis a room of one hundred square feet would call for two or four, sixteen candle-power lamps.

It is easy to see that the rule becomes arbitrary, only in so far as the distance of the light source from the surfaces to be illuminated is varied. But even this question is readily settled by reference to the fundamental law of light, namely, that the intensity varies inversely as the square of the distance between the light source and surface receiving the light. For instance, if an incandescent lamp six feet above a surface of twenty-five square feet, lights it well enough to read by, the elevation of the lamp to a point ten feet above the surface, would mean a reduction of the light intensity on that surface, to just one quarter of what it was before. It has frequently been noticed in large auditoriums where the lighting is bad and reading is difficult, that there is often plenty of light there, but the lamps are too high up and therefore an unpleasant effect is produced.

The expert is necessarily forced to observe these facts in order to prevent inevitable complaints when the lighting contract is complete. The quantity of light anywhere, is thus seen to be no solution of the lighting problem; and it cannot always be left to the wiring contractor in a case of great responsibility, for the simple reason that he is always quite willing to install an excess of lights, thus making his job bigger and more profitable where the case from this standpoint, calls for just sufficient light and no more. Theaters, concert-halls, and auditoriums are excellent examples of lighting problems, for the reason that the ceilings are very high, the light distribution on the different tiers is somewhat complex, and those in the orchestra are largely dependent for the light they get upon the center or centers of light above. An observance of the two rules, first, that of getting a certain candle-power per square foot wherever people are sitting, and secondly, that of not guessing at the light effect produced by lights high up, will reduce the problem to such a degree, that it may more readily belong to the æsthetic than the scientific. When the points have been secured at which lights may be most efficiently placed, the new question arising in the mind of the expert of illumination, is that of light and color effects. Getting sufficient light, and getting certain light effects, are not necessarily identical terms, nor have they equivalent meanings. It is one thing to get enough light, and yet another thing to arrange that light artistically. This is readily recognized by the decorators not only of theaters, halls and places of worship, but of homes as well. Tone effects as well as sufficient light and light effects are among the necessities of the hour. A well-trained light expert has his hands full in meeting all these conditions in practice. It is readily seen, that some art training is as necessary in one respect, as the engineering and scientific experience in the other respect. Solving light problems belongs to a new as well as an old profession. It has only been emphasized more of late than before, through the enormous spread of electric lighting, and its established position in the field of modern illumination.

The central station is the institution which gave rise to this new profession, and the managers of

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these establishments know better now than they ever did before, that while their business is that of selling electricity for light, they cannot escape the responsibility in many instances, of giving advice not as to the amount of light needed, but regarding the best positions to place it in. Science and art clasp hands at this point of progress, a fact well understood by the illuminating expert in the course of his varied experiences.

Refilled Incandescent Lamps

Whatever prejudice may have existed in the past in regard to the unreliability and lack of uniformity in the process of refilling burned-out incandescent lamps or those which developed early defects in their filaments, has been entirely eliminated by the present scientific and careful methods adopted by the few leading refillers of the country. It was, of course, natural to suppose that any new process would encounter stumbling blocks which only persistence, careful thought and experience could eliminate, and in regard to the refilled incandescent lamp of to-day, it may be said that this product is now a standard article of supply and one which central station managers generally will find to their advantage and economy to consider most seriously. A visit to one of the largest refilling lamp factories in this country will show the businesslike and thorough method which is now adopted and which is placing upon the market a refilled lamp which, when it leaves this factory, is as perfect a lamp, and in many cases a more perfect lamp than when it left its original maker, and this is borne out by reports made on these refilled lamps by the Electrical Testing Laboratories of New York.

When it is taken into consideration that one factory alone in Malden, Mass., is now turning out ten thousand perfectly refilled lamps a day and is barely able to complete its repeat orders from central stations, employing a force of one hundred and fifty employees, it shows conclusively that the state of the art of renewing incandescent lamps has long since passed the experimental "hit or miss" stage. The fact that a large user of incandescent lamps is thus able to get a perfect product, should make him consider the careful preservation and handling of his burned-out or otherwise exhausted lamps for the purpose of having them refilled, resulting in a considerable saving in his annual lamp bill which, next to the coal bill, is one of the most important factors in the success of many central stations.

CURRENT IDEAS

For Furnishing More Light, Heat and Power from Central Stations

Methods of Securing Power Business*

By Geo. N. Tidd.

It seems to me that our attitude toward the power problem should be, that there is no reason why our plants should not furnish all the power used by manufacturers and others in the city, with possibly the exception of those manufacturers who use a larger amount of steam or heat in their process of manufacture; notably paper mills, who steam their pulp and use their engines simply as reducing valves.

An examination of the steam plant of the average manufacturer will show many examples of poor steam engineering and a high cost of energy delivered for actual production. One will usually find they are using comparatively expensive coal and frequently teaming the coal in and the ash out. They are probably purchasing their water from the city and feeding it to the boilers with injectors. The boilers are frequently poorly set and operating at poor efficiency. The engines are probably of inferior design, old and in poor condition; usually slide valves or high speed automatic, and in many instances either over or under loaded.

The frictional load of shafts and belts frequently will represent 20 to 50 per cent. of the power produced. Their labor cost will be high when considering the amount of power actually consumed in

* Paper read before the National Electric Light Association, Washington, D. C., June 7, 1907.

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producing useful work. It would, therefore, appear, with our high efficiency generating plants, methods of burning low grade fuels, low labor costs (due to large outputs and labor-saving devices), together with the savings we can secure by the elimination of a larger portion of the frictional line losses due to motor drive, that we should take over all the power business of the district, and not confine ourselves to a comparatively few short hour, low loaded factor class of consumers.

As to some of the methods of attaining this desired end, I would suggest:—

First.—Secure the services of a good operating engineer for the work, a man, if possible, who has been in charge of a central station plant, and one who can appreciate quickly the points involved in good and poor steam engineering. This man should be a good salesman, and, with one or more assistants, can cover a good deal of ground by devoting his entire attention to the work.

There are many men operating the smaller plants who are admirably adapted for the work. The varied experiences secured by such men in operating these plants, with the numerous difficulties encountered and overcome every day, make them particularly resourceful and valuable for the work. I take my hat off, every time, to the man in charge of the average small central station plant.

Second.—Canvass of District.—Have your power man make a thorough investigation of every power-producing plant in the district, no matter how large or small. Keep a systematic record of every case along lines suggested in a plant data sheet. A thorough study of each power problem should be made, which, supplemented with a study of the process of manufacture, will develop business that at first sight would be deemed impracticable to secure, owing to steam or fuel conditions. This analysis prepares the representative to meet the owner or manager, in a measure, upon his own ground, and having a close approximation to the total costs of the plant, conditions of operation and load factors, puts him in a position where he can talk and argue most effectively. His grasp of the situation is tremendously increased. These records are invaluable, as in some instances it is not possible to close a prospect until he has a breakdown, and when it comes all the data are instantly available.

Third.—Secure a Large Representative Installation.—The first large customer comes hard. After the ice is broken, others have more confidence in your proposition and are easier to handle. It will, therefore, be of great aid to secure one of these customers to whom you can send and take prospects. The customer should, if possible, be one of the leading manufacturers. There are always one or more manufacturers in a district who are naturally the leaders, and others are very apt to consider whatever they do the proper thing. Make the most important manufacturer your friend and a booster; make his installation a model one, and you will find his aid invaluable. There is nothing so effective in arousing the interest and desire of a prospect as having him examine and see a large installation in operation, and talk with the owner or manager on the many advantages over the old steam drive.

Fourth.—Trial Demonstration.—We frequently meet prospects who are dubious as to the advantages of central station drive in their particular business or conditions. They admit it is good for their neighbor, but for this reason or that, it is not suitable for them. In other words, they are from Missouri and "need to be shown." In these cases, I would install the complete equipment and furnish current to operate for 60 or 90 days' trial. Usually they will agree to pay a nominal sum, representing their acknowledged costs for the service, and in many instances will further agree to provide the motor foundations and belts. Under these conditions the expense of such a trial is merely nominal, as all the apparatus can be removed and used elsewhere. There are many advantages in such a trial.

First: The organization of the local steam plant will deteriorate, and in some instances vanish, so it is hard to get together another gang; the inertia of a change has been overcome, and you have it on your side in finally closing.

Second: It demonstrates much better than you can tell the advantages of close speed regulation, with its consequent increase in output, the freedom from plant troubles and worries, the flexibility and cleanliness, and, above all, gives you an accurate determination of the actual amount of power required to drive the plant under favorable conditions.

It has been the writer's experience that fully 95 per cent. of these trial installations are finally closed.

Fifth.—Methods of Selling.—Be liberal with your prospects in regard to terms of payment for the motors. In many instances it is advisable to sell upon the installment plan and allow one or two years to pay for the installation. The small manufacturer especially needs the money in his business and cannot afford to make the necessary outlay in cash for the proper installation. By taking a lease upon the apparatus and insuring it against fire, you are pretty well protected. In some instances it may

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be necessary to install a motor free, if it secures a particularly favorable business. The rate per kilowatt hour can be easily increased enough to cover the cost of the motor. In other words, allow nothing to stand in the way in the line of a reasonable investment in securing good motor business.

Sixth.—Remember that every power prospect, especially if it be a large one, must be considered largely as an individual proposition. You cannot make a hard and fast system of rates which will apply to all cases. Do not be afraid to go down on high load factor business, simply because your present cost with its low load factor is higher than perhaps you will be called upon to quote. I would suggest dividing your costs up into readiness-to-serve and output expense; dividing the connected load into the total readiness-to-serve expense, and the output expense by manufactured current. This will give an indication of the value of high load factor business and what it can be sold for. Therefore, do not be afraid to go down on the long hour business.

Off-peak Business.

This class of business does not seem to have been given the consideration it deserves. Many stations believe it is not possible to secure any amount of this character of business. If, however, every power prospect be carefully analyzed and working hours studied, it will astonish you to find how much business can be secured on this basis. Wherever a manufacturer works two shifts it is usually possible to so arrange the hours that they will avoid your six o'clock overlapping peak. The proposition requires care in presenting to the manufacturer, for at first thought he will say that it is not possible, but if your man has his conditions thoroughly in mind (and he should not talk until he has) he can in many instances persuade the prospect to shorten the noon hour, start one-half hour earlier in the morning and shut down early enough during the winter months to avoid the overlap. For instance, flour mills can easily shut down during overlapping peak hours, foundries by getting out their iron somewhat earlier, and many others are in the same class. Flat rates in connection with this off-peak business work in very advantageously. I am aware of the prejudice of all central stations against flat rates, and to some extent I share this for unlimited flat rate lighting. However, I do not believe flat rate power business is in the same class. The manufacturer will not pay for labor or wear and tear upon machines simply to waste current. He has a clearly defined number of hours to operate, a certain maximum production to obtain in these hours, and a definite number of machines to operate. A flat rate peak load contract can thus be easily drawn which will cover the situation fairly well. Say nothing about the horse-power required. The company merely agrees to furnish energy in sufficient quantities to drive a certain number of carefully described machines a certain number of hours per day. The contract is very useful in landing certain classes of men and business which could not be otherwise obtained.

MONTHLY REVIEW OF THE TECHNICAL PRESS

The Electrical Engineering Profession

By Ernest T. Williams.

Twenty years ago an engineer with a knowledge of electricity was in a position to reap the benefits of a market in which the demand was greater than the supply. The natural result was that the electrical profession became the "Mecca" of aspiring parents for their brilliant (and otherwise) sons,

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and a large number of youths commenced an oft-times expensive training in the hope of reaping a future golden harvest. Many of those who entered in the earliest years have moderately realized their anticipations, but others coming later did not find the demand so great, and, though new appointments were constantly opening up with the extension of electrical application, the number of qualified men open for appointment continued to increase at a greater rate, until it can fairly be said that the prospects of a youth just finishing his training are not brilliant; we might ask if they are even good, or, compared with some other professions and most businesses, even reasonable. Undoubtedly in Great Britain the supply of qualified men is much greater than the demand, and yet there is an ever-increasing number of youths pouring into, and out of, the training colleges, until there is a glut on the market, and some of the most promising are at the outset of their career doomed to realize that the law of supply and demand is a grave factor in life, and that the chance of their attaining the positions which were to give some return for much sacrifice, labor, and expense involved in their training, is an ever-decreasing one. If such is the case to-day, what will it be 10 or 15 years hence, when the number of qualified electrical engineers will have increased by hundreds, perhaps thousands, whilst the wastage due to death, and to those who have left the profession, will be comparatively insignificant? It is to be hoped that by that time the tide will have turned, that unwary parents will have learned the true conditions, and that the influx of new men into the profession will be reduced to a normal healthy supply.

We might ask what is to become of those already launched into the profession, and of others who are entering it—do we realize that the great influx is likely to cheapen it, and cause comparatively good positions, which are obtained after years of work and experience, to be less remunerative and secure—and, lastly, can nothing be done to reduce the evils spoken of, and to raise the status of the profession to the level of those most recognized and honored by the world?

One has but to read the letters which occasionally appear in the technical papers to realize that many young electrical engineers are experiencing the greatest difficulty in obtaining appointments at a bare living wage, and even when successful the prospects are not such as to justify marriage, with its immediate and prospective responsibilities. It would be well if many such were to consider the prospects of electrical engineers abroad. The writer hopes in a future article to deal more fully with the various aspects of life abroad; given fair prospects the question deserves every consideration. The business or commercial side of engineering might with advantage be looked into, especially when there is any evidence of good business capacity; or the question of taking up some other branch of engineering in which one's electrical knowledge and experience would be valuable, might be considered. In other words, and whilst fully recognizing the value of consistency, it would be well for young engineers to realize that few men are able to run the course mapped out by them in their youth, and successful ones are often those who have availed themselves of the opportunities which have arisen, though these may not have been what were desired or had been planned, instead of waiting for just what they wanted to turn up. Even more might be done; if the opportunities do not appear to come to them, they must endeavor to make their own—if the river will not come to you, then you must go to the river.

There can be little doubt that the great supply of young engineers is to some extent due to the energy of technical training colleges and to electrical engineers or firms who take pupils.

No fault can be found with the taking of pupils when practiced in reason—just the opposite; but can an engineer be said to be upholding his profession when he takes a far larger number of pupils than the concern of which he is the head can justify? It has not been an uncommon thing to see a small central station or a small works almost run by pupils, who not only pay premiums to the engineer or firm, but by their working at little or no salary are keeping other men out of positions they reasonably expect to obtain. Is this kind of thing honest, or just to the pupils themselves? They become pupils trusting in the good faith of the engineer that they may reap a reasonable return—is he promoting that end by his methods? We might pause and ask whether there is not a moral obligation on the authorities of a training college, or on an engineer, to endeavor to point out to a youth or his parents what the prospects are before he sets out on his career; they might by this lose something, but the gain to society and to the profession would be great.

It is not pleasant to think that many electrical engineers themselves have done much to cheapen the profession, but we fear this is the case. Some station engineers, for instance, have been so anxious to reduce their expenses another decimal point, or

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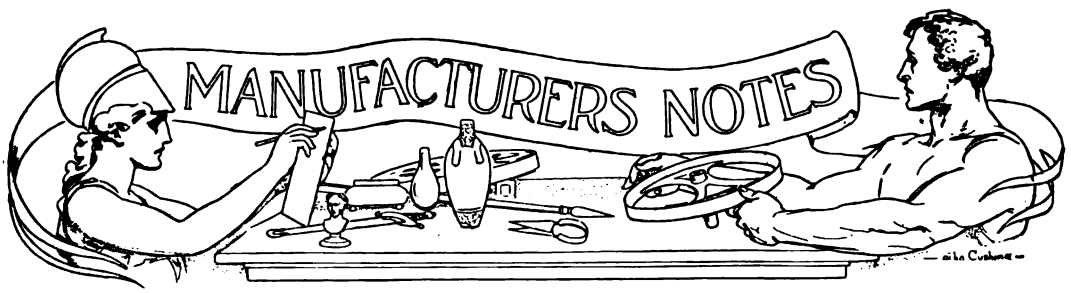
to make a few more pounds profit on the undertaking, that they have countenanced the payment of what might be called starvation wages to the qualified assistants who are helping them to bring about the desired results. Let it be made quite clear that every possible praise is due to the efforts to obtain economy when they can be justified, also it should not be lost sight of that the question of salaries is one over which some committees exercise entire control, often against the engineer's recommendations; but there is reason to think that many engineers themselves have been to blame for advocating low salaries, or for having allowed their continuance without protest. A little thought will show that this is a short-sighted policy, and in time must not only react on the profession but also on themselves.

We cannot pass this point without in justice recognizing those engineers who have worked on entirely different lines, and there are not wanting signs which indicate that under some of our most respected engineers the assistants' salaries and positions are more in keeping with the training and experience required. It should not be lost sight of that an engineer who advocates the payment of reasonable salaries is not only loyal to himself, his assistants, and the profession, but also, to the greatest extent, to the undertaking he controls, as it is well-known that good men are a great factor for efficiency, and if reasonably paid are more likely to remain with the undertaking, to its advantage—on the other hand, good men who are underpaid are unsettled and on the lookout for something better; this may partly account for the name electrical engineers have got for constantly moving about.

Finally, we might ask can nothing be done to raise the tone and status of the profession generally? Our great representative Institution is that of the Electrical Engineers and largely upon it depend any results. We may feel justly proud of the Institution and of its work, and, representing a new profession, it has opened wide its arms and embraced—wisely we think—many who would under other circumstances not be entitled to membership. This openness, on the other hand, has allowed many to flow in who are not a credit to the profession; might it not be pertinent to ask whether the time has not arrived when a higher standard should be fixed, so that membership of the Institution may stand for some guarantee that the holder is a fully qualified electrical engineer and a member of the profession? It is not suggested that any present member should be voted out, but rather that new entries should be so regulated as to make association with the Institution something to be worked for and sought after.

The electrical technical journals have done much in the past for the profession; may we not hope that though so crowded with technical matter they will be able to do even more in the future? The influence and power of the press is impossible to estimate, and if its whole weight were used to raise the tone and status of the profession, the result would be invaluable. Lastly, we have electrical engineers themselves—each one should cultivate that love for, and loyalty to, his profession, which is seen in some other professions; all respect is due to those who have been, and are, working for this end. As a profession we have grown quickly, and believe we are healthy and strong—now we want consolidating, trimming into shape, and to be imbued with that *esprit de corps* and loyalty, which in a nation is patriotism, and attains that which without it, would be impossible.—*London Elec. Review.*



Helios Manufacturing Company, of Bridesburg, Philadelphia, Pa., manufacturers of the well-known Bastian Electrolytic meters, have just issued a new and comprehensive twenty-four page catalog illustrating and describing the Helios flaming arc lamps. "A light rivaled only by the noonday sun, yet as

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soft as that of the silver moon." This catalog goes into the theoretical and practical description of these lamps, and at the same time gives a detailed description of the complete lamp, as well as each separate and distinct part of same, all of which are numbered and cataloged, making it a very simple matter to order any part of the lamp without having to return the complete lamp to the factory when any slight repair or new part is necessary. These lamps are furnished in eight distinct types, each one described by a separate bulletin as given below:

"HELIOS" Multiple Direct Current Enclosed Lamps, 100-125 volt circuits, Bulletin No. 26.

"HELIOS" Multiple Direct Current Enclosed Lamps, 200-250 volt circuits, Bulletin No. 27.

"HELIOS" High Efficiency Multiple Direct Current Enclosed Lamps, 100-125, volt circuit, Bulletin No. 29.

"HELIOS" Multiple Alternating Current Enclosed Lamps, 100-125, 200-250 volt circuits, Bulletin No. 28.

"HELIOS" Series Alternating Arc Lighting System, Bulletin No. 32.

"HELIOS" Series Direct Current Enclosed Lamps, Bulletin No. 25.

"HELIOS" Multiple Twin Carbon Enclosed Lamps, 200-250 volt circuits, Bulletin No. 24.

"HELIOS" Series Multiple or Power Circuit Enclosed Lamps, Bulletin No. 23.

While commenting upon the excellent annual report of the Westinghouse Electric & Mfg. Company, a well-known local financier remarked:

"One of the most important factors that has brought about the phenomenal business records of the company within the last year is the perfect organization which dominates all departments. It must be extremely gratifying to Mr. Westinghouse, whose business sagacity and foresight brought this about, and it cannot help being pleasing to the stockholders to know that their property is under such an efficient management."

E. M. Herr, the chief executive under Mr. Westinghouse, has had exceptional experience as an engineer and manufacturer. He was for a time the successful head of the locomotive department of the Northern Pacific Railroad, where he showed great tact in the management of men and won a national reputation for his expert skill in the construction and operation of locomotives. In 1898 he became vice-president and general manager of The Westinghouse Air Brake Company, and it was his remarkable record in that position which undoubtedly prompted Mr. Westinghouse to place Mr. Herr in charge of the Electric Company at a time when his qualities were quite essential to its success. Mr. Herr became vice-president of the Electric Company in 1905, and his connection has proved most effective in improving the affairs of the company.

L. A. Osborne, the second vice-president of the company, in charge of the engineering and commercial departments, is a remarkable young man who, though he is but 35 years old, has demonstrated during his career with the company an engineering skill as well as a capacity for management which place him among the leading men of the industrial development of this country. He is familiar with every detail of the company's engineering and commercial work, and since Mr. Westinghouse, a year ago, placed him in the important position which he now occupies, he has proved a great success.

In the engineering department, the leading men are B. K. Lamme, C. F. Scott, H. P. Davis, N. W. Storer and others, all known to the electrical profession the world over for their valuable contributions to the great achievements in the electrical industry during the last twenty years. To them belongs the credit for the development of the single-phase alternating current railway motor and the many details essential to its operation, an achievement which makes the Westinghouse Company the most important factor in the modern electrification of railroads.

To these men also belongs the credit for the product of the Westinghouse Company having gained a world-wide reputation for superior electrical excellence and perfect mechanical construction.

The Electric Cable Co., of New York, has just bought the entire business of the Eastern Wire and Cable Co., of Roxbury, Mass. The latter company is one of the oldest and largest manufacturers of rubber covered wires and cables in New England. Its entire equipment will be removed to Bridgeport, Conn., where it will be installed in the plant of the Electric Cable Co., which has in course of construction a large addition to its plant. The officers of the Electric Cable Company are, President, Edwin W. Moore; Vice-President, F. H. Cowles; Treasurer, J. Nelson Shreve.

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The Northern Engineering Works, of Detroit, Mich., one of the largest and most important manufacturers of electric cranes and hoists in the world, have recently installed a power station electrically operated traveling crane of twenty tons capacity for the Toledo Gas and Electric Company, of Toledo, Ohio, and two similar cranes of twenty tons capacity in the Murphy Power Plant at Detroit, Mich.

Golden-Anderson Valve Specialty Company, of Pittsburg, Pa., manufacturers of steam and water specialties, have just issued their new catalog No. 9, consisting of fifty-six pages illustrating and describing the Anderson cushioned non-return valves, reducing valves, and "Clean Seat" valves, and cushioned check and hand-stop valves, together with the Golden patent high and low pressure tilting steam traps. This company also manufactures a very complete line of automatic float valves.

The Elblight Company of America, 36 East 23rd St., New York City, furnished for the Elks' Convention held at Philadelphia, during the third week in July, over twenty-five thousand Elblight lamps for electrical decorations. Of these the Philadelphia Edison Company used four thousand, the City Hall three thousand and the department stores and other establishments eighteen thousand.

Messrs. McKenney & Waterbury Co., 181 Franklin corner Congress St., Boston, Mass., are showing the largest line and newest things in gas, electric and oil fixtures, for residences and hotels. An order for any quantity can be filled from their immense stock at once.

The Trumbull Electric Manufacturing Company of Plainville, Conn., has recently published a new bulletin of their Type "A" switches, which shows a large extension to the line, and many changes and improvements are made. The bulletin covers 34 pages, and represents the most complete line of any one type of switches ever published.

Four-pole switches are listed, also new code fused switches, with high fingers for fuses both on the hinge and handle end, and a complete line of switches for alternating current from 15 to 2,000 amperes.

The bulletins will be gladly sent upon request to all those interested.

This company has also recently put out a complete new line of panel circuits and switch parts. This is a line unique in the market and is designed to meet the increasing demand of those who wish to get their own slate or marble and arrange the circuits as they desire.

With these parts a man does not have to depend on the factory for an additional circuit or some slight change.

The freight rates are so much lower on slate than on completed panels that the saving in transportation charges will be influential in increasing the demands for these panel parts.

They are constructed for National Electric Code or plug fuses.

Bus-bars can also be furnished as well as the necessary lugs, so that complete unmounted panels can be obtained.

Dunton & Field, 117 Main street, Cambridge, Mass., manufacturers of the Dunton tree insulator, which is now becoming the standard insulator for this class of work, are now up to the capacity of their factory in turning out these insulators, not only on new orders, but on repeat orders.

Many of these repeat orders are from central stations which have not ordered for eighteen months, showing conclusively that the test of time has proved their value, and they are giving excellent satisfaction.

The United States Government, after two years of consideration, has just awarded to the Westinghouse companies a contract for the complete electrical equipment of the power station now being erected in connection with the new Congressional buildings in Washington, D. C. It will be a most modern plant located about four blocks south of the Capitol in Garfield Park, and will, when finished, furnish heat, light and power for the group of buildings immediately surrounding the Capitol, namely, the Congressional Library, the new Senate and House Office Buildings, and the Capitol itself. The contract calls for four 3,000 H. P. Westinghouse-Parsons steam turbines and four 3,000 H. P. Westinghouse generators. The machinery will all have to be delivered before the end of the present year, when the plant is expected to be in full operation. All of the apparatus is now being constructed at the East Pittsburg works.

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Saving from Death by Electric Shock

By Frederick Strang Kolle, M.D.

1st. Lay the patient on his back.

2d. Move the tongue back and forth in the mouth by seizing it with a handkerchief or the fingers, while working the arms to induce respiration.

3d. Don't pour anything down the patient's throat.

4th. Try to cause the patient to gasp by inserting the first and second fingers in the rectum, and pressing them suddenly and forcibly toward the back.

5th. If possible, procure oxygen gas, and try to get it into the lungs during the efforts at artificial respiration.

6th. Get a doctor as quickly as possible.

7th. Treat the body as though it had been under water, by trying to obtain artificial respiration.

The above items have been arranged in the manner given, to avoid the immediate necessity of reading that which follows, in cases of emergency. It is quite natural to realize, that the victim of shock must be pulled out of circuit or disconnected from the wires carrying the current. To do this, a stick of dry wood, a piece of dry cloth, a coat or soft felt hat, may be used. It will be understood, therefore, that means are taken, more or less familiar to the electrical man, for removing the body from continued danger of this kind; the best to use being of course rubber gloves for this purpose, if convenient.

Air in the Lungs.—The patient must be made to breathe *at once*. To accomplish this, lay him on his back with a coat under his shoulders to throw out the chest. Then, lift the arms over the head and back again, until they press against the chest. This process will force air in and out of the lungs, as required. A second party ought to assist in pulling the tongue forward, when the arms are raised above the head, and let it fall back when the arms press against the chest.

Rate of Breathing.—The rate of breathing produced artificially should be about sixteen times a minute; a little more or less will not affect the general result.

Jaws Locked.—If the jaws are locked by the clenching of the teeth, force them open with a knife or spoon handle, or their equivalent, so that the tongue can be seized and moved as described.

Effect of Tongue on Teeth.—By the rubbing of the lower side of the tongue on the under row of teeth, the patient is apt to gasp automatically, and thus fill the lungs with air. The fact that an effect of this kind is possible is a good sign, and should be produced at intervals of a few seconds if possible.

Time of Keeping up Artificial Respiration.—The operations indicated should not be discontinued for a long time. In many cases an hour or more is required before the body even begins to resume its natural functions, as shown by the beginnings of ordinary breathing.

Throat Free.—The throat must be free to admit air, when the lungs are inhaling, by the upper movement of the arms. The movement is similar to that transpiring during the process of yawning and stretching the arms above the head. The inhalation must be made as deep as possible and the operations leading to it continued with systematic care until results are visible. Filling the throat with the back of the tongue at the wrong time, will mean failure. Therefore, the movement of the tongue back and forth must be intelligently performed.

Paper Cone for Oxygen Gas.—An inhaling cone may be made of paper, the larger end over the patient's face, and the smaller end or stem attached to the oxygen tank by means of a piece of rubber pipe. A little oxygen in the lungs, causes a strong heart action, and operates to revive very quickly.

Friction of the Limbs.—Rubbing of the body is a secondary means of hastening the blood circulation. The inactivity of the lungs and heart are due to a temporary paralysis or shock caused by the passage of the current. The removal of this condition means resuscitation, part of which process may be carried out by massage of the body and limbs.

General Character of the Treatment.—As may have been noted in reading this popular version of the means of assisting recovery from shock by electricity, the general drift is in the direction of getting the patient to breathe and his heart to beat strongly. Other legitimate ways may be tried, but they must not be so heroic, as to induce death during so critical a condition. The continuances of an accepted method is better than irrational experiments. These should be checked at once, and the above program followed out, until a physician takes charge of the case.

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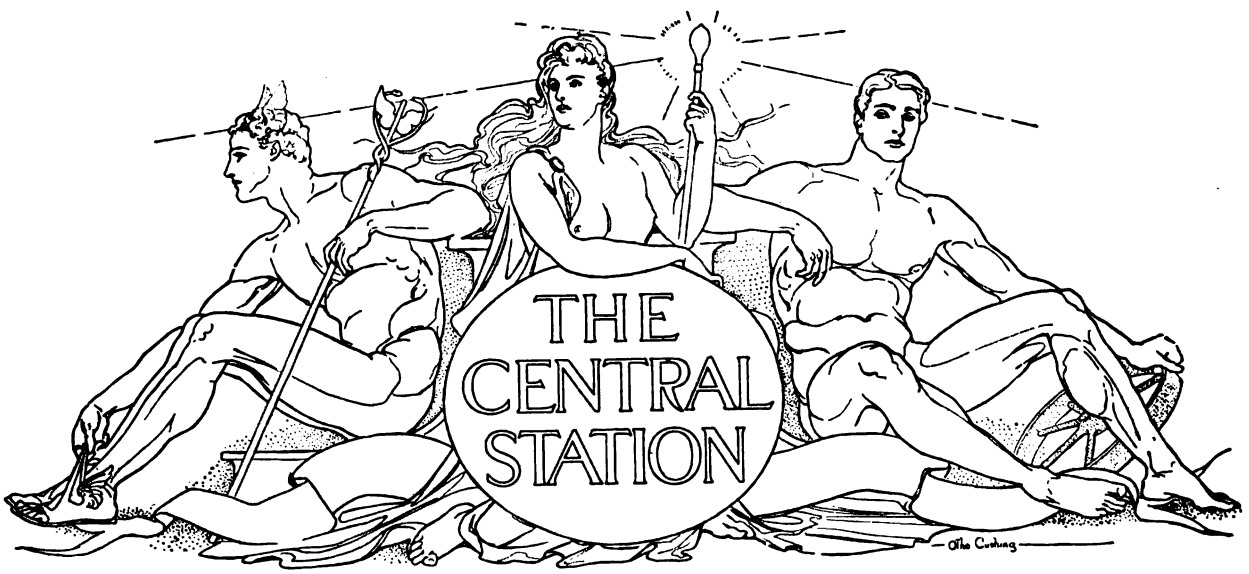

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, NO. 4. NEW YORK, OCTOBER, 1907. ISSUED MONTHLY

Central Station Light, Heat and Power Principles

BY NEWTON HARRISON.

Measuring the Resistance of Insulation.—Insulation has resistance, though it is enormous compared with conductors. An insulation, so-called, is not an absolute non-conductor, but a very poor one. The idea is relative. A pressure of 1,000 volts applied to a resistance of 1,000 ohms would mean a current of 1 ampere. A pressure of 1,000 volts applied to a resistance of 1,000,000 ohms would mean a current of 1/1000 of an ampere. If the pressure is lower, the current is correspondingly less. A telegraph line is supported on insulators. Though made of glass, these insulators permit current to leak from the line to the ground. Not one alone is responsible for the entire leakage, but the total. An infinitesimal current from one, multiplied by the number of insulating supports, would give the total current. If, in the above case, the one-thousandth of an ampere was multiplied by 10,000, the total would equal 10 amperes. This is not entirely an imaginary case for the reason that 10,000 insulators, at the rate of 25 to the mile, would only equal 400 miles between stations. The leakage per insulator might be less than that stated, but whatever it was it would be multiplied by 10,000 on a 400-mile line. Not only is it necessary to know the relative merits of insulators for line service in order that line leakage may be reduced to its lowest value for telegraphic and other lines, but the insulation of power-carrying wires must be known as well. The following is an outline of the method of measuring insulation resistance, by the principle of the substitution of one resistance for another. The requirements are a metal pail, a sensitive high resistance galvanometer, and a carefully tested high resistance. With these, the value of the resistance of high grade insulation, reaching into the millions of ohms, can be found.

The insulator, or insulated wire, is so placed in the water that the current passes through from the metal pail into the conducting solution into the insulation, and then out via the wire. If a coil of insulated wire is tested, consisting of say 1,000 feet of rubber covered wire, then one end of the wire is carefully coated with tape and an insulating compound. The other end leads out, also a separate wire connected to the metal pail. The coil is laid in the pail and covered with water slightly tinctured with sulphuric acid (No. 1), a few drops, to lower the resistance of the water. The preliminary test is then made with a resistance of 10,000 ohms, which will cause a deflection of 50 divisions in the galvanometer.

Supposing the galvanometer to possess a resist-

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ance of 10,000 ohms, the first galvanometer deflection is due to 20,000 ohms in all. Removing the 10,000 ohms resistance from the circuit, the insulated coil situated as described in the water, is substituted in its place. If the deflection in this case is only one division, then it is clear that 50 times the resistance is in place now. In other words, where 20,000 ohms gave 50 divisions, it has taken 1,000,000 ohms to cut this down to one division. Of the 1,000,000 ohms, 10,000 are due to galvanometer resistance. The balance of 990,000 is the resistance of the 100 feet of insulated wire in the metal pail. As a single foot of wire would be higher than this, in fact 100 times as great, it may be stated that according to the test one foot of this wire has an insulation resistance of 100 times 990,000 ohms, or 99,000,000 ohms, commonly called 99 megohms.

Method of Substitution.—Measuring resistance by the method of substitution is really a compara-

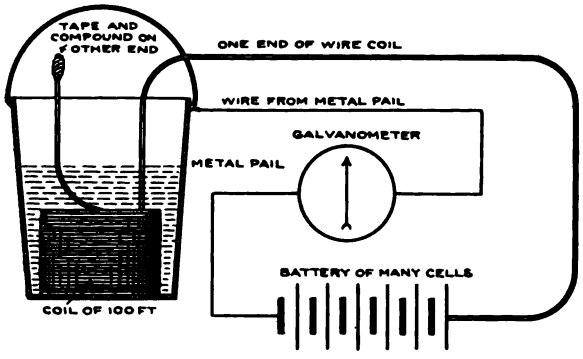

FIG. 1.—MEASURING INSULATION RESISTANCE OF RUBBER COVERED WIRE.

tive method. If a certain known resistance will cause an indicating instrument to show a deflection of 100 divisions; and then, when another resistance is put in its place, the deflection falls to one-half, or 50 divisions, it is evident that the resistance must be twice as great. The reason for this is found in the reduced deflection. This means less current or more resistance. If the conditions are otherwise the same, the drop in the reading of the indicating instrument to one-half proves the presence of twice the resistance. Ohm's law as stated, that the current is directly proportional to the electromotive force, and inversely proportional to the resistance, means, when applied to this case, that if the electromotive force has not changed, but the current is one-half, as shown by the deflection, the resistance is twice as great. To illustrate this idea, a galvanometer must be connected to a cell of battery (No. 2), and a known resistance of say 100 ohms. If under these conditions the galvanometer gives a reading of 20 divisions, the record will read, 100 ohms 20 divisions. If the 100 ohms is removed, and an unknown resistance, such as a lamp, is put in its place, suppose the galvanometer now shows a deflection of only 5

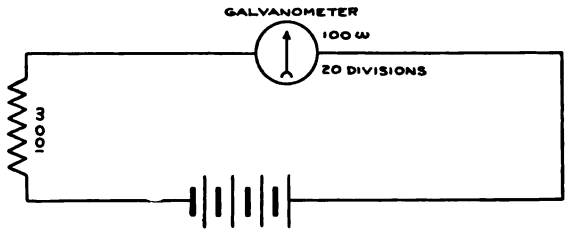

FIG. 2.—GALVANOMETER AND RESISTANCE CAUSE DEFLECTION OF 20 DIVISIONS.

divisions. The conclusions to be drawn are as follows: If 100 ohms gives a reading of 20 divisions (No. 3), and an unknown resistance gives a reading of 5 divisions, then the unknown resistance must be greater.

Its resistance is so much greater that it reduces the current down from that value which gives a 20 division reading, to a value so much less that only a 5 division reading is possible. If the galvanometer readings are greater or less, in strict proportion to the current passing through it, then a 20 division reading and a 5 division reading fully express this idea. The reading has been reduced in the galvanometer from 20 to 5 divisions because the current passing through it has been reduced. The reduction is due to the new unknown resistance substituted for the known resistance. If the reading was cut down from 20 to 5, the current must have been cut down in like proportion. Its reduction to one-quarter of its original value is due to the fact that the resistance must be four times as great.

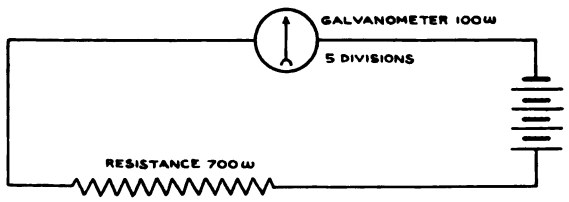

FIG. 3.—GALVANOMETER AND A SUBSTITUTED RESISTANCE CAUSE A DEFLECTION OF 5 DIVISIONS.

If the resistance in the first case was known and valued at 100 ohms, in the second case the diminished reading to 5 divisions shows the presence of a resistance, which in conjunction with that of the galvanometer must equal four times [illegible] original.

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If the galvanometer = 100 ohms then the proposition shows that 100 + 100 = 200 ohms, causes a deflection of 20 divisions. It also shows that 100 + an unknown resistance gives a deflection of 5 divisions. The question that naturally arises is, "What is the unknown resistance?" As previously stated, it

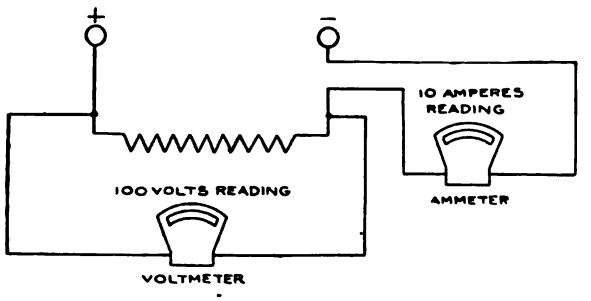

FIG. 4.—RESISTANCE OBTAINED THROUGH DROP AND CURRENT VALUE.

must have taken four times the resistance to reduce the reading from 20 to 5 divisions. This being the case, the 200 ohms in the first instance must have been increased to 800 in the addition of the unknown resistance. If the galvanometer resistance, however, is 100 ohms, then the unknown resistance must be equal to 700 ohms.

Thus, the method of substitution as outlined, calls for a knowledge of the resistance of the galvanometer or indicating instrument. It also calls for a knowledge of the value of the first resistance interposed. With these facts known, it is evident that any reasonable resistance may be substituted for the first, and if the deflection is taken, its resistance readily calculated.

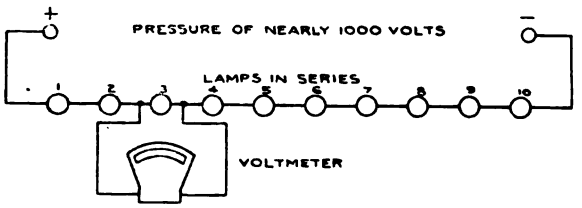

FIG. 5.—VOLTMETER TAKING THE DROP IN EACH LAMP IN THE MEASUREMENT OF HIGH PRESSURES.

Drop of Potential Method.—There is no reason to believe that a simpler method than this can be presented in developing the idea of resistance measurements. It is based upon the proposition contained in one form of Ohm's law that the pressure which is necessary in a circuit, to send a given current through a given resistance, is equal to the product of this current by the resistance. In other words, if the proposition is given—find the resistance of a circuit whose lost pressure or "drop" equals 100 volts when carrying a current of 10 amperes—the answer can be readily given on the above basis.

A loss of 100 volts, or whatever it may be, is caused by a certain current passing through a definite resistance. The problem, in arithmetic form, then becomes 100 = 10 times what value? It is quite evident that the value to be found is 10. The drop in pressure between the ends of the circuit being 100 (No. 4), and the current being 10 amperes, the resistance must be 10 ohms. The drop of potential method, therefore, consists of the measurement with a voltmeter of the drop of pressure between the ends of a circuit through which current is passing.

The next step is the measurement of the current itself with an ammeter. Dividing the volts by the amperes will give the ohms as indicated. The test may be made in other ways, which merely represent modifications of this idea without any real change in the method. For instance, if the resistance of the circuit is known, it is a simple matter to find the number of amperes passing by ascertaining the drop in exactly the same manner. The drop in volts divided by the ohms will give the amperes.

On the other hand, the idea may be still further developed for the purpose of discovering the volts consumed by the circuit. In this case the resistance, which is known, is multiplied by the current which is measured. The product will give the volts lost or "drop" of the circuit. The general idea thus presented covers a means of obtaining the resistance if the amperes and volts are known; the volts, if the amperes and ohms are known; and finally the amperes, if the volts and ohms are known. It is legitimate to include all of these tests under one general category. Examples crystallizing the application of these methods are given in a tabulated form in the following simple arrangement of this idea:

DROP OF POTENTIAL METHOD.

To get ohms:—
Measure the drop and measure the amperes. Divide E by C.
To get amperes:—
Measure the drop and know the ohms. Divide E by R.
To get volts:—
Measure the amperes and know the ohms. Multiply C by R.

This system shows how a voltmeter is used for measuring amperes when the resistance is known. It shows how to measure volts with an ammeter when the resistance is known; and finally, it shows how to calculate the resistance of a circuit if its drop is measured with a voltmeter and its current with an ammeter.

Measuring High Pressures.—If this principle is

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applied to the measurement of pressures like 1,000, 5,000, or 10,000 volts the following plan is practicable: Either 10, 50 or 100 lamps are connected in series. If about 1,000 volts are to be measured (No. 5), about 10 lamps will do. The total pressure is then sent into this series as shown. A voltmeter is used for the purpose of taking the drop between the terminals of every lamp. The total is found when all results are added together. For instance, if the voltmeter indicated as follows:

1st lamp.....	90 volts	6th lamp.....	98 volts
2nd "	95 "	7th "	99 "
3rd "	100 "	8th "	102 "
4th "	110 "	9th "	85 "
5th "	105 "	10th "	87 "

Then the total equals the sum of 90 + 95 + 100 + 110 + 105 + 98 + 99 + 102 + 85 + 87 volts or 971 in all. An early method of measuring the high pressures of alternating currents before high reading voltmeters were made is thus shown.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Injuries to Servant of Power Company from High Potential Current While Making Repairs—Assumption of Risk

Suit was brought to recover damages for causing the death of a lineman in defendant's employ. The lineman was sent to replace cross arms which had been burned from a pole during a fire in a nearby building. The insulation had been burned off the wires and considerable ice had formed on the pole from water thrown by the fire department. It was a mild day, and the pole and cross arms were wet from the ice melting on the pole. The deceased proceeded with the work, and placed two new cross arms on the north side of the pole directly opposite the two old burned cross arms, and was assisted in the work by Pat Joy, a groundman or helper. Between one and two o'clock in the afternoon the deceased was discovered burning on the pole. An experienced lineman, Robert Waters, and the superintendent of the defendant, Grant Hall, who happened to be nearby, immediately went to rescue the deceased; but life was extinct before he was reached. The deceased was standing on the north side of the pole with a safety belt around his body and the pole, with one foot on the new secondary cross-arm; the other foot resting in the iron climber stuck into the pole. The body was leaning toward the west, resting on the cross-arm and high potential wires; one hand resting on each of the two wires on the west side of the pole. Parts of both hands were burned off. The right arm was also burned on the inside about two inches from the elbow up into the armpit, and about ten or twelve inches down the side. The right shoulder was burned also on the outside, and there were several small burns on the body in other places. The deceased was nineteen years of age at the time of the accident, had attended the German Catholic School from the time he was seven to twelve years of age, had worked for some time in a butcher shop, and for about two and one-half years had worked at inside wiring and as telephone lineman, and for about six or seven months immediately before his death had worked as lineman for the defendant on high potential wires. The case had been previously tried and had been heard by the Supreme Court, at that time a new trial being granted on the ground that it was a question for the jury whether he was not guilty of negligence in not turning off the high potential current before sending deceased to work upon the wires and pole. Upon the second appeal the court said, on the last trial, and to meet the situation thus presented by the decision of this court, the defendant presented as witnesses the two engineers in its employ at the time of the death of the deceased and for years im-

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mediately prior thereto, and they both testified to the effect that, if the current is turned off, the engineer in charge of the plant at the time knows it, and that during the time they had been so employed by the defendant the current had never been turned off for the purpose of making outside repairs. Such testimony is undisputed, and so the court charged the jury that: "Risks of employment are always assumed when the servant knows or ought to have known the dangers incident to the conditions under which he works, and all ordinary risks and hazards of the occupation in which he is engaged are assumed, whether the servant appreciates them or not. Zentner, by engaging in the work of lineman for the defendant company, assumed the ordinary risk incident to such employment. The evidence is undisputed that it was the custom of the defendant to keep the current on while repairs were being made on the high potential line under all ordinary conditions and circumstances. Zentner must be presumed to have known of this custom." The jury manifestly appreciated the importance of the question, for, on returning to the court, they requested that the court's instructions on the third question of the special verdict should be read to them; and the foreman then asked the court: "Is not that a question of vital importance as bearing upon the other questions?" The court replied to the effect that "it was for the jury to determine the facts upon the evidence under the instructions of the court, and for the court to render judgment upon the facts found by the jury." Thus it appears, not only from the deliberate finding of the jury, but from the undisputed evidence, that the deceased "did know the current was on while he was making such repairs." And so we are squarely confronted with the question propounded by Mr. Justice Kerwin on the former appeal: "Did the evidence so conclusively establish contributory negligence, or that form thereof known as "assumption of risk," on the part of deceased as to warrant the court in taking the case from the jury?"

According to the undisputed evidence, and the charge of the trial court above quoted, it did. There seems to be no escape from the conclusion that the deceased was guilty of that phase of contributory negligence known as the "assumption of risk." Schlemmer v. Buffalo, Rochester & Pittsburg Ry. Co., 205 U. S. 1, 27 Sup. Ct. 407, 51 L. Ed. The facts mentioned being undisputed, and as declared by the trial court, it was manifest error to refuse the defendant's motion to change the answer to the fourth question of the special verdict from a "No" to "Yes," and then enter judgment thereon in favor of the defendant.

The judgment of the circuit court is reversed, and the cause is remanded, with direction to enter judgment in favor of the defendant as indicated in this opinion.

Zentner vs. Oshkosh Gaslight Co. (Wis.) 112 N. W. Reporter 449.

Liability for Death or Injury from Electric Current—Continued—Duty and Liability to the General Public—General Principles

The courts have gone far in fixing rules governing the liability of those who are engaged in trafficing in the electric current in so far as the duty of such persons or corporations to the general public is concerned. The courts have in many cases considered the general principles which should govern the relations between the public and the vendors of electricity, and have in every instance imposed upon the company a very high degree of care. In fact none of the public utilities are required to exercise so great a degree of prudence with reference to the general protection of the general public as is required to be exercised by power companies. The reason for this especially burdensome treatment, paralleled by that accorded no other agency, not excepting common carriers, is based on the peculiar nature of the substance dealt with. Its subtle character, the fact that it is impalpable, not to be detected by ordinary sense unless especially trained and cautiously exercised, combine to give a cast to the judicial mind, who exacts from lighting and power companies a degree of care almost tantamount to making them insurers.

It is also my opinion that a want of thorough understanding of the natural sciences and something akin to superstition has induced the courts in the earlier cases to look upon this electric current and its vendors with disfavor, but be the reasons for this legal situation what they may, the fact remains that an unusually high degree of care is exacted by the law of vendors of electric light and power.

A highly interesting case upon this phase of our subject is that of Denver Consolidated Elect. Co. v. Simpson, 21 Colo. 371, 41 Pac. 499, 31 L. R. A. 566, July, 1895. In this case the court said: "The employment of electricity for supplying light is of comparatively recent origin. The best methods of constructing lines for its distribution, and the precautionary steps to be taken to guard the public from the dangers incident to its use, may not be known or fully understood. But enough is known to justi-

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fy the statement that the business of distributing electricity on wires strung over the streets of a city is a dangerous business, and attended by peril to travelers along the highway. This court does not recognize any degrees of negligence, such as slight or gross, and logically it ought not to recognize any degrees in its antithesis, care. The court instructed the jury in this case that the defendant was not an insurer of the safety of plaintiff, but that, in constructing its line and maintaining the same in repair, it was held to the utmost degree of care and diligence; that in this respect it is bound to the highest degree of care, skill, and diligence in the construction and maintenance of its lines of wire and other appurtenances, and in carrying on its business, so as to make the same safe against accidents, so far as such safety can, by the use of such care and diligence, be secured. If it observed such degree of care, it was not liable. If it failed therein, it was liable for injuries caused thereby. We think the court was unfortunate in attempting to draw any distinctions in the degrees of care or negligence. It would have been safer and the better practice to instruct the jury—which ought hereafter to be observed—even in cases like the one before us, that the defendant was bound to exercise that reasonable care and caution which would be exercised by a reasonably prudent and cautious person under the same or similar circumstances. In addition to this, the jury should have been instructed that the care increases as the danger does, and that, where the business in question is attended with great peril to the public, the care to be exercised by the person conducting the business is commensurate with the increased danger. But, in effect, this is what the court did. Under the facts of the case, the law required of the defendant, conducting, as it did, a business so dangerous to the public, the highest degree of care which skill and foresight can attain, consistent with the practical conduct of its business under the known methods and the present state of the particular art. This is the measure of the duty owed by a common carrier to a passenger for hire. Thomp. Carr. p. 208, and cases cited.

Not for the same reason, or because the doctrine rests upon the same principle, but with even greater force, should this rule apply to a person or corporation engaged in the equally, if not more, dangerous business of distributing electricity throughout a city by means of wires strung over the public alleys and streets, in so far as is concerned its duty to the traveling public. In those courts where degrees of negligence are not countenanced, nevertheless, in cases where the duty of a common carrier of passengers is laid down, the jury are told that carriers are bound to the utmost degree of care which human foresight can attain. This is upon the theory that reasonable or ordinary care in a case of that kind is the highest care which human ingenuity can practically exercise, and that, as a matter of law, courts will hold every reasonably prudent and careful man to the exercise of the utmost care and diligence in protecting the public from the dangers necessarily incident to the carrying on of a hazardous business. Where the facts of a case naturally lead equally intelligent persons honestly to entertain different views as to the degree of care resting upon a defendant, the court ought not to lay down a rule prescribing any particular or specific degree in that case. But where all minds concur—as they must in a case like this one we are now considering—in regarding the carrying on of a business as fraught with peril to the public, inherent in the nature of the business itself, the court makes no mistake in defining the duty of those conducting it as the exercise of the utmost care. It was therefore not prejudicial error for the court to tell the jury in this case what the law requires of the defendant, viz., the highest degree of care in conducting its business. The late case of Block v. Milwaukee Street R. Co. 89 Wis. 371, 27 L. R. A. 365, rightly interpreted, supports this doctrine, and the case of Haynes v. Raleigh Gas Co., supra, expressly lays down the rule observed by the trial court in the instructions given in this case.

The foregoing considerations dispose of all the errors assigned which we deem necessary to notice.

The judgment will be affirmed.

Large Gas Engines

The accompanying illustration shows the type of gas engine now being built by Allis-Chalmers Company, Milwaukee, for the power-house of the Indiana Steel Company's new works at Gary, Ind., and for other large installations as mentioned on page 711.

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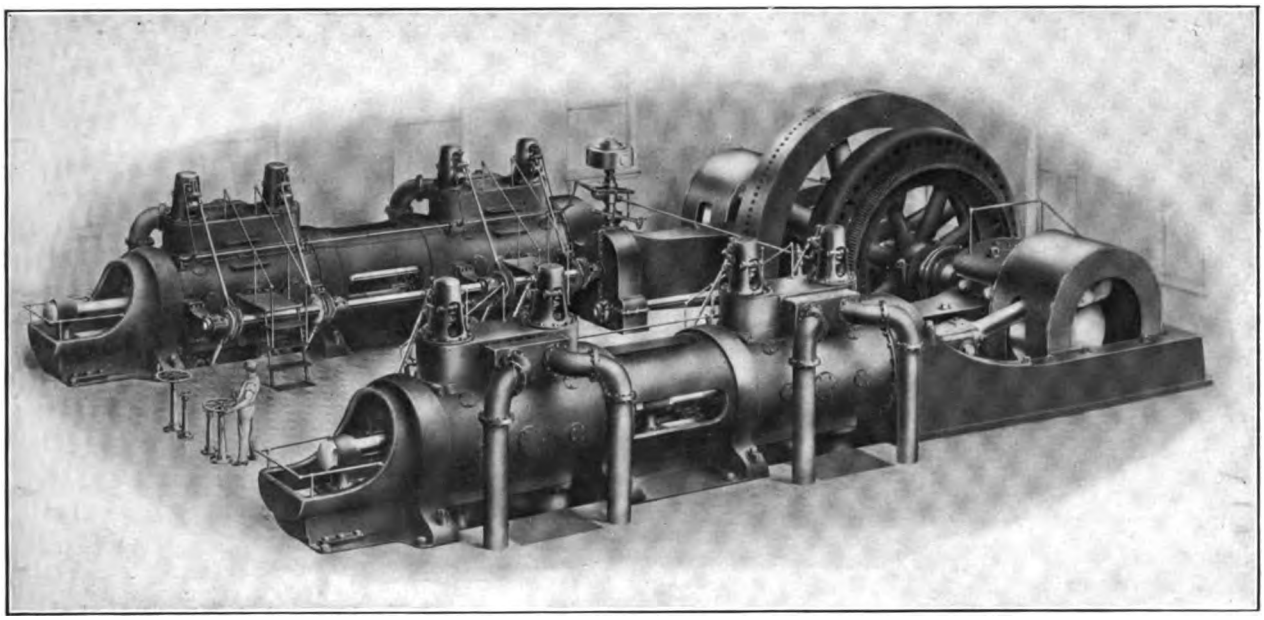
These engines have the largest cylinder diameter of any gas engine yet built in this country, the sizes being 44 inches in diameter by 54 inches stroke. They have the same volumetric capacity as the engines built for the California Gas and Electric Company, which are 42 inches in diameter by 60 inches stroke. An engine of this size on blast furnace gas of about 80 to 85 B. T. U. will give a safe maximum horse-power in the neighborhood of 4,000, but will work up to approximately 5,000 h.p. on the richer gases. The valve gear is located between the engines, concentrating the gear on a twin tandem in a way that makes it very convenient for the operating engineer. This engine, as shown, is of the cut-off type, the quantity of gas and the time of admission both being under the control of the regulator. Allis-Chalmers Company is building thirty-six (36) of the size mentioned. In one power-house at Gary there will be 17 Allis-Chalmers units of that size, 15 of which will be connected to 25-cycle alternators (rated at 2,000 kw. but which will, of course, have large overload capacity), and 2 will be direct-connected to direct-current generators, also of 2,000 kw. rated capacity. The power-house is approximately 125 ft. wide and 1,000 ft. long. Another power-house being built at Gary of the same width and one-half this length is also to be equipped with Aliis-Chalmers units.

The weight of the engine is, in round numbers 1,500,000 lbs.; the crank-pins are 20" in diameter; the shaft is 30" in diameter in the bearing, and the fly-wheel is 23 ft. in diameter, weighing 200,000 lbs. The speed of this engine is 88 1/3 r. p. m. The pistons and rods are water cooled, water being introduced at the center and flowing forward to a discharge in the frame for the front piston and backward to a discharge in the tail guide for the rear piston, each piston having its separate supply. For dismantling or for cleaning, the rod is made in two parts joined at the central slide, the rear half going out at the rear of the engine and the other half going out through the frame, which is made open at top for convenience.



ALLIS-CHALMERS FOUR-CYCLE, DOUBLE ACTING, TWIN TANDEM GAS ENGINE DIRECT CONNECTED TO ALLIS-CHALMERS 2,000 KW. ALTERNATING CURRENT GENERATOR.

The frames for this engine weigh approximately, 90 tons each, and one-half of each frame is buried in the foundation, in order to raise the floor line to a point which will make the slides on the valve gear readily accessible.

The new power stations of the North Shore Electric Co., at Waukeegan and Blue Island, near Chicago, are furnished with alternating current electric Northern cranes, furnished by the Northern Engineering Works, of Detroit, Mich. These cranes are 30 tons and 25 tons capacity, respectively, 58′ and 39′ span. The larger crane is equipped with an auxiliary high-speed, 5-ton alternating-current hoist.

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The Value of the Nernst Lamp to the Central Station

By A. E. Fleming.

Probably no other piece of apparatus made so little change or improvement as did the incandescent lamp, until about four years ago, when a watt per candle was hailed as a great improvement. Within the last three or four years more new types of lamps have been brought out than at any time during the thirty years' existence of the incandescent lamp. With the introduction of these new types has come a remarkable change in the sales policy of central stations. The most progressive have not only taken advantage of high efficiency lamps, but also have become more liberal and broad-minded in their dealings with the consumer.

We now have to consider the tungsten, tantalum, the metalized filament, and among the arc lamps, the luminous and the flaming metallic arc. The Cooper Hewitt and the Moore tube must also receive attention.

It is interesting to note the change which has come over the papers presented to the National Electric Light Association since the convention held at Denver, Colo., in 1905. Previous to this convention the topics most generally discussed were saving of small losses in generating and secondary distribution. Now, however, the papers presented deal with "How can we best sell our current?" This subject has brought out new ideas with regard to making rates, systems of renewal, methods of advertising and securing new business, co-operation between the central stations, manufacturers, contractors, architects, engineers and consumers. It has also developed a demand for the services of competent illuminating engineers in the employ of central stations.

The question of the value of a high efficiency lamp has been thoroughly discussed, and from actual practice there is no question with regard to the benefits derived. If this is not the case, why should not manufacturing companies be receiving a demand from the central station for four and five watt lamps instead of a demand for increased efficiency? The central stations now realize that they must be more enterprising than heretofore, and give the consumer the benefit of improved service, which includes the most efficient lamp that can be procured.

We need no better example of the effect of supplying consumers with increased light for the same money than the experience of gas companies with the introduction of the Welsbach mantle.

Of all the high efficiency lamps now on the market none have been submitted to more severe and rugged tests than the Nernst lamp has received.

It has passed the experimental stage some years ago, and to-day is as much of a commercial proposition as the enclosed arc lamp or the three and one-tenth watt incandescent. It is now a standard piece of apparatus, and with some central stations represents their standard lamp of high candle power, they no longer furnishing arc lamps or a high candle power incandescent.

The Nernst lamp is, as most of you are aware, the salvation of electric light companies in meeting gas and gasolene competition. It has enabled the central station manager not only to retain dissatisfied customers, but also secure new business from competing gas companies. This is verified by the report of the Committee on Progress of the National Electric Light Association, presented by Mr. T. C. Martin, before the convention in 1906, which is in part as follows: "It appears to be the general experience that one three-glower Nernst lamp taking 264 watts is able in commercial practice to replace the ordinary four-burner gas 'arc' lamp; and this is confirmed by some recent tests, which show that the useful light from a three-glower Nernst is about the same as that from a four-burner gas 'arc.' Assuming the Nernst lamp to be supplied with electrical energy at ten cents per kilowatt hour, the cost of operating the three-glower 264 watt Nernst lamp would be 2.6 cents per hour. Four-burner gas lamps, when burning at an efficiency making them comparable with three-glower Nernst lamps, consume in the neighborhood of 20 cubic feet of gas per hour, making a cost of 2.5 pents per lamp hour, with gas at $1.25 per thousand cubic feet. With the cost to the user approximately the same, the electric light naturally has always the preference."

An example of what can be done is illustrated by the experience of the Yonkers (N. Y.) Electric Light & Power Company, which is also mentioned in Mr. Martin's report, above referred to, as follows: "The first Nernst lamp installed by the company was in January, 1903, and one of the most

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notable instances of its successful employment to win over the shop-keepers of a small city to the cause of electric lighting has been at Yonkers. Gas there sells at $1 per thousand cubic feet, but so successfully has the electric company pushed the Nernst lamp that gas and gasoline arc lamps have almost entirely disappeared. Many shops, although still equipped with ordinary Welsbach mantle gas lamps and gas arc lamps, use the Nernst lamps in preference. The company supplies the Nernst lamp free of charge and looks after its maintenance, with the result that the business has grown enormously. On June 1, 1905, the number of Nernst lams installed was as follows: 196 one-glower lamps, 382 three-glower lamps, and 13 six-glower lamps—a total of 501 lamps, with 1,420 glowers. The growth since then may be gauged from the number in use on March 1 of this year, which is as follows: 638 one-glower lamps, 571 three-glower lamps, and 10 six-glower lamps—a total of 1,219 lamps, with 2,411 glowers, making an increase of over 100 per cent. in the number of lamps connected in nine months."

The Nernst system consists of five units for use on alternating current circuits of 110 or 220 volts, 25 to 133 cycles, for indoor and outdoor service, which are classified as follows:

The one-glower lamp, consuming 88 watts at 220 volts, will replace three 16 c. p. incandescent lamps, or one gas mantle.

The two-glower lamp, consuming 176 watts at 220 volts, will replace seven 16 c. p. incandescent lamps.

The three-glower lamp, consuming 264 watts at 220 volts, will replace ten 16 c. p. incandescent lamps, or one four-burner gas arc.

The four-glower lamp, consuming 352 watts at 220 volts, will replace fourteen 16 c. p. incandescent lamps, or one 6 ampere a. c. enclosed arc lamp.

The six-glower lamp, consuming 528 watts at 220 volts, will replace twenty 16 c. p. incandescent lamps, or one 7½ ampere a. c. arc lamp, or one 5½ ampere d. c. arc lamp.

The two and three-glower lamps place in the hands of the central station two units for which there has been a demand for a number of years, that is, a lamp which would come between the arc lamp and a high candle power incandescent lamp.

A very important advantage of the Nernst system not possessed by any other is that the five units are all of the same color value, thus enabling us to get away from the detrimental effect of operating arc and incandescent lamps in the same interior. This feature was one of the strongest points which led to the adoption of the Nernst lamp for the lighting of the large Pennsylvania depot and terminals in New York City. The illuminating engineers in charge of this work had one of the most difficult propositions to consider that has ever come before the lighting world. From the lighting of the main waiting room, which is approximately three hundred feet long, one hundred feet wide, one hundred and sixty-seven feet high, down to a small office of sixteen by twenty feet, with a ceiling twelve feet high, was the task which confronted the engineers, and after careful consideration and exhaustive tests it was decided to use approximately fifteen thousand Nernst glowers.

That the Nernst lamp gives the proper light for stores hardly needs any further recommendation than the fact that it has been adopted by Marshall Field & Company, of Chicago, for the lighting of their thirty-eight acres of floor space, replacing forty thousand incandescent lamps and necessary fixtures by approximately twelve thousand glower units.

The objection of high initial cost of the Nernst system is often raised by engineers not thoroughly conversant with the subject. They do not stop to consider the low power factor of the arc lamp, which necessitates additional outlay in secondary distribution, transformers and station equipment. This additional cost should be charged in all justice to the arc lamp equipment, or we must open a new account, to which can be charged the additional investment in apparatus. If it is placed, where it properly belongs, against the arc lamp, you will find that the Nernst lamp costs very nearly fifty per cent. less per unit.

Another objection which we often hear against the Nernst is the high cost of maintenance, and that it necessitates "expert" labor to maintain it. If a man who trims and looks after arc lamps can be considered an expert this statement is true, though it is not generally conceded that such labor is considered high class or expert, but more properly comes under "experienced." There is nothing new about the general system employed in taking care of Nernst lamps; it has long been in vogue with the large central stations in handling their arc lamps. At the prevailing guarantees and prices on Nernst lamp repair parts in Canada, they can be maintained for six-tenths of a cent per kilowatt hour, though some central stations, which are now using the largest number of lamps, claim that they are maintaining them for three-tenths of a cent per kilowatt.

That the Nernst lamp is making rapid advancement in Canada is proved beyond a doubt by the fact that in less than two years over twenty thous-

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and glowers have been installed. In the United States there are now in operation over one million glower units.

In marketing the Nernst lamp several methods are open to the manufacturer, through the jobber, supply dealer, contractor, through the central station, or directly to the consumer. The channel chosen was through the central station, as the manufacturer believed this was the best way to reach the consumer.

Some of the advantages of the Nernst system to the central station are as follows:

In aiding the central station to change their flat rate to meter rate contracts.

As an effectual means of meeting gas competition.

As a means of presenting something new to the prospective customer.

As a means of obtaining a larger volume of business which may be classed under the heading of "advertising," such as window display illumination, lighting of store fronts and special street lighting.

As a means of broadening the peak, due to the ability of the central station to obtain a large number of small consumers, who as a rule have a connected load very nearly equal to their daily peak consumption.

Another advantage lies in the fact that while central stations have been trying to "sell current at the meter," they now generally recognize the fact that they must go further and act as illuminating engineers, and accordingly become more interested in actually selling illumination.

There are now sixty central stations in Canada and seven hundred and fifty in the United States purchasing Nernst lamps under contract with the manufacturer.

Though the Nernst lamp is established as a thoroughly commercial proposition, improvement will go on, new types of lamps will be developed, and everything done to render the lamp a benefit to the central station. The latest lamps to be placed on the market are the single vertical glower series lamp for street lighting, and a 220 volt direct current lamp in one, two and three-glower sizes.

We cannot lay down any rule for the marketing of Nernst lamps which would apply in all localities. The demand for any article is based, first, upon its merit, and second, upon the publicity given the article and its advantages. There is no question about the advantage of the Nernst lamp to both the central station and the consumer. The manufacturer is desirous of co-operating with the central station in various methods and mediums of publicity, to create a demand for the Nernst lamp as an inducement for the use of current.

We sincerely request that central station managers adopt a policy of being in closer touch with their consumers, that they keep themselves in line with up-to-date methods of obtaining business, and that they educate their consumers to the longer use of light. This also applies to the number of municipal plants in Canada. The consumer cannot be expected to study out the lighting proposition for himself, and it is the duty of the central stations to give the customer the benefit of their knowledge of all economical methods of lighting, and the sooner that this is done the sooner we will hear less about the grasping monopoly, the indifferent corporation, the arbitrary and independent electric light company.

Mr. H. M. Hirshberg, the president of the Excello Arc Lamp Company, of New York City, has just returned from an eight weeks' trip abroad.

During this trip, Mr. Hirshberg not only visited the large works on the outskirts of Leipsic in Germany, where the Excello arc lamps are made, but also inspected the arc lighting systems of London, Paris, Berlin, Brussels, Frankfort, Cologne and Neurnberg.

The factory in which the Excello arc lamps are manufactured, and which is situated in Leutzsch, an outskirt of the city of Leipsic, is the largest exclusive arc lamp factory in the world, having over one thousand men on its pay roll, including over a hundred expert electricians and designers.

The machinery used in the manufacture of these lamps requires over 1,500 horse-power to operate, and the rapidly increasing demand for Excello arc lamps, both in this country and abroad, has required additions to this factory every year for the past ten years.

The large number of gas and electrical engineers, architects and central station men who are becoming interested in illuminating engineering, and who call upon the Holophone Company for data on this science, has led to the engagement by the company of Mr. T. R. Pemberton, in the position of office salesman and demonstrator. The Holophane Company has a very complete demonstration room, in which the illumination value of its product is shown.

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The Central Station

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New Lamps for Old

The reputed value of old lamps as an index of progress, is not supported by fact to the extent one would anticipate. Engineering prognostications, and those arising from opinions based upon laboratory experiments, differ in one essential detail. The laboratory produces the newer and better lamp all the time. In other words, the trail of experimental science leads to a goal many are striving to follow, in this energetic search for the new lamp in place of the old. It is not difficult to see the drift of modern invention in the development of the incandescent lamp. To the novice, it appears to be merely a commercial tendency, the object being cheapness. To the more experienced observer, the commercial objective point is hidden, while the more complex problem appears, and a multitude of difficulties, practical and scientific in nature, which must be overcome.

Cost, economy and durability, are the governing influences which mould a lamp into being. And however unique the invention that the lamp or its parts presents, the commercial question naturally dominates the whole after completion—the question of "cost." Thus, the proposition relating to lamps that are being invented is twofold in its bearing upon the case: first, the development of the lamp as a scientific accomplishment; second, the introduction of the lamp as a business venture. It is evident that two entirely distinct though related enterprises present themselves on this basis. One is admittedly the inventor's work to the point of practical operation, the other is that of the manufacturer in its exploitation and money making power.

A tendency widely noted to-day, to introduce a lamp with other than a carbon filament, is entirely due to the new paths opened up in the field of chemistry. In following up electrical inventions the fact must not be lost sight of that allied industries reciprocatively give and take as far as possible on account of the bearing one has upon the other. For instance, the advance of the chemical science lends itself to the equal advancement of those departments of the electrical science, which are waiting for more knowledge in this direction. The incandescent lamp filament and the storage battery are prominent examples of this fact, and in consequence a move forward by one either in the field of pure science or industrially, means progress in all directions where points of contact exist between the advancing field of thought and others related thereto.

The use of ultra carbonized or metallic filaments, simply presents the old problem, even though new lamps appear. The old problem was ever present, as to-day, in its imperious demand upon scientists. inventors and manufacturers, to put forth a lamp at least cheaper to buy, longer to live, or more saving in power. The ways and means therefore, are like other influences found everywhere, only an effort to make the fittest type survive. This effort. denominated invention on the one hand, and business push on the other, is continuous, though those developing it represent many individuals and many business sources.

For instance, the metallized or graphitized carbon filament has been introduced as a step beyond the ordinary filament, and it is claimed, cuts down the

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power consumption to 2.5 watts per candle with a life of 600 hours. Then come the Nernst, osmium, tantalum and tungsten filaments, entering into active competition with the older types on a business basis that denotes fundamental value. Following these are the inventions in lamps of the tube form, mercury vapor and so-called vacuum, as types that have been introduced as new lamps in place of the old.

The reduction, in each test, of the power consumption, below that of the regularly recorded values given for the last decade, shows conclusively that the new lamp, whatever it may be, which is cheaper, more economical to run, and as durable as the older type, will only fight to first place, so to speak, inch by inch. Advance has been limited in lamp manufacture because of the sluggishness with which new ideas were accepted and "mined out" as it were.

Radical departures meant new knowledge very hard to obtain, however impetuous the attack made by the inventor upon the problem presented. Contributing influences leading to success were derived from undeveloped sources in many instances. It is on record that inventors seeking for success have had to open up new fields in related sciences. This is neither new nor unexpected as far as experience goes, and it is only strange that in some instances the advance was as great as occurred.

In addition to the requirements noted, which must be fulfilled before new lamps take the place of the old, the important commercial necessity of strength to stand shipping is needed. However good lamps may be, they must be able to stand handling without fracture, to more than a small degree. In this respect, the lamp that fulfils all conditions but this is lost at the start in the competitive struggle.

Finally, it must be understood, that no substitute for existing lamps can be found in other than those which produce as good an admixture of light waves as the old. Quality of light, as well as cheapness in operation and cost, goes hand in hand with durability in securing the much desired commercial supremacy.

The Refractory Filament

The more refractory a filament is, the more to be expected from the lamp in the way of life and efficiency. But the limit of refractoriness has been so closely approached, that it is worth while considering in some detail the advantages, direct and indirect, that may arise from this condition. A refractory filament is one which can stand a very high temperature without deterioration. Its advantages lie in its superior economy as a basis for illumination as compared with less refractory substances used for the same purpose. Platinum, for instance, originally the metal employed for the earliest lamps, proved less refractory than carbon, which led to their successful introduction on a commercial scale. But the transformations even the carbon filament passed through before it eventually became what it is, represent an interesting page in the history of its evolution.

A refractory filament is not only a necessity in lamp manufacturing, but is the only basis on which to build a lamp of permanent value. The critical point is that at which the light begins to increase disproportionately to the power. The three watt rate per candle power is, in the average lamp, but the stepping stone that leads to real success. It is realized that in a lamp of this kind a filament able to stand a higher temperature without destruction, would produce much more light with a slight accession of power. The gain of one-half a watt per candle power has been successfully accomplished, as evidenced by the two and one-half watt lamps now put out by reputable concerns. These advances, being evidences of an intelligent appreciation of the meaning and value of a more refractory filament, the next step is to examine into the indicated results along these lines of progress.

An inoxidizable filament would be best comprised in the form of a rare oxide, now in vague in advanced lamp construction. Its refractoriness is sufficiently great to illustrate the value of substances of this description for practical lamp construction. The trend of experimental work is entirely along the lines of greater refractoriness in the material experimented with. The number of substances that have passed through the crucible lilterally, would reach hundreds. Of them all but a few have survived the test that betokens usefulness.

A certain glowing surface of filament is what gives light in incandescent lamps. The more intense the glow of light, the higher the temperature developing it. The logic of events shows no such proportion, however, as would be expected between the amount of light and the temperature. An incandescent surface gives as much light as its superficial area produces, but not all that the substance it limits could give if properly exposed to the eye.

For instance, a superficial area of one square inch may bound a mass of material which is capable of having two, three or more square inches of sur-

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face if differently shaped. Other things being equal, a greater surface at the same light-giving temperature would mean more total candle power or more light. The hint given in these remarks, therefore, is to the effect that the interior substance whose outer surface is giving light might be made to give light also if its conformation were adequately changed. In other words, a mere film of incandescent material would give the same light whether it were only a film or the external surface of a thick block of refractory material heated to a light-giving temperature. A very refractory substance, therefore, distributed over a large area, and heated to a vivid point of incandescence, can be made to give a great quantity of light. The possibility of using films of highly refractory material as the basis of a light source becomes apparent, provided no extraordinary means are required to produce light by this method.

Aside from original suggestions, however, the era is rapidly approaching in which the filament of lamps will be composed of material that will develop light as it should be made. Being so near to ultimate success, and still so far removed from the possibilities of failure, speaks well of the prospect in sight. Too much power has heretofore been wasted in producing little light of a questionable quality. The potentiality of science at least lies in its positive power to give us good cheap light and leave the old bypaths so well trodden.

A horse power or a kilowatt represents an amount of energy which can readily produce immense quantities of light if properly utilized. Certain light giving insects have been observed, and it has been noted, that their manner of producing light is such that very little energy is expended. The production of an equivalent amount by our methods would mean the physical exhaustion of the insect in a very short time. For this reason it is made evident that nature does not intend a waste of energy to occur in her light making processes. And it thus becomes evident, that far less power than we use, would give us the same amount of light in any specific case.

On this basis, where a kilowatt now gives the equivalent of about 4,000 candle power, on the new economical basis the future may have in store for us, 30,000 or 40,000 candle power may be produced instead.

A Straight Filament Tube Lamp

Variations of the customary form of incandescent lamps appear from time to time and demand consideration. When the form is such, however, that the question arises as to its permanency, certain considerations are necessary in order to arrive at a conclusion not at variance with the truth.

The form of filament generally adopted heretofore, has been of the horse-shoe type, and this is sufficiently well known to require no other than passing comment. The only reason fundamentally, that could inspire a change from a bent horse-shoe form of light-giving medium to one of different shape, would be a decided advantage in either the quantity or diffusion of the light. On this basis, the diffusion or distribution of the light, it is very possible to gain advantages that will appeal to the lay as well as the technical mind. The problem demanding the attention of many of our most skilful technicians is as much caused by the form of light or lamp, as its economy, cost, or life. For this reason, the lamp must be of such a character as to leave no room for speculation as to its merits. Its construction must make its functions apparent at a glance, and thus arouse positive appreciation in the eyes of its users or critics.

It is curious to realize how readily the step is made from an accepted form, to one that differs in a particular which completely changes the value of an invention. The tendency noted in the field of inventive work in this respect is that of arriving at the first success with a complex form of the original idea. The second success is reached practically by a much simplified form of the original device, a form attained only by the elimination of what is other than obvious, and the preservation only of the obvious, and therefore the simplest parts of the apparatus.

In lamp design, the bulb has so far held to a shape which is pear-like, and is generally accepted as the logical outcome of a variety of experiments to vary it. Its general acceptance has led to the conclusion that the form was fixed and a change would not be beneficial, which was in the main true, though only so with respect to the shape of the filament. With a change in shape of the filament, however, a proposition holding true for a horse-shoe shape, is evidently not correctly quoted for a straight one. In other words, a straight filament, the use of which is advantageous, calls for changes in other details of construction and design as may be found in a new lamp now on the market.

The facts relative to this developed form of the old lamp are given as follows:

"The Straight Filament Tube Lamp is unique in its light giving qualities. The lamp is operated at

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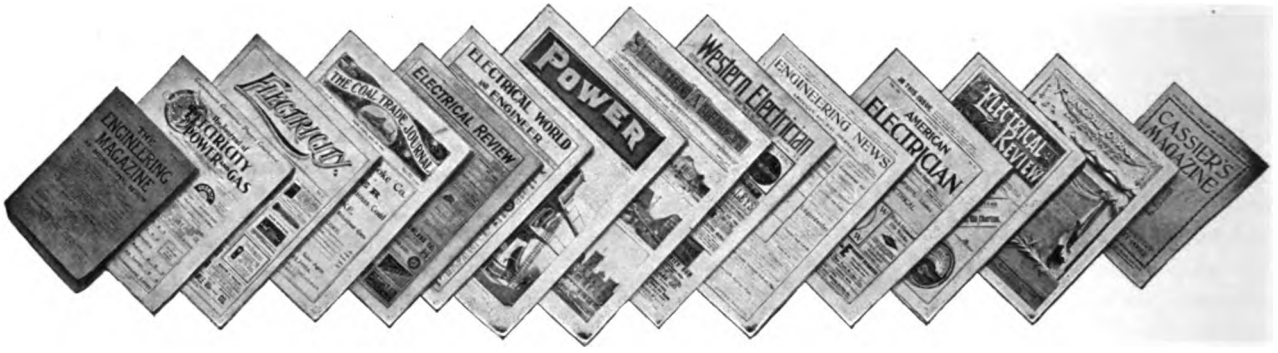
the same voltage and current and consumes the same wattage as the standard bulb lamp. Its average candle power by photometric measurement in a plane at right angles to its axis is 33 candle power as against 16 candle power for the corresponding standard bulb lamp at its best angle of light emission. With the standard reflector, the lamp gives, by photometric measurement, an average of 78 candle power in a plane at right angles to the axis of the lamp, showing an efficiency of 0.77 watts per candle power."

This invention, the work of D. J. O'Brien, has thus manifested unexpected qualities by a rearrangement, so to speak, of the old material. If there is anything in the term "effective lighting" there is at least something to be said about the efficiency of light distribution. If a decided gain is possible by a change of form, then that change must be accepted and indorsed by those convinced of its value. The straight filament has considerable to recommend it at least on the basis of simplicity, but the theoretical interest assumed in an invention of this kind will not mean its success. The true success is found in that form of competition which overrides existing types to a degree which publishes its value as a useful innovation.

A straight filament tube lamp, therefore, has merits, according to the above test by Edward R. Knowles, which make it well worthy of examination. The test is a sufficiently good letter of recommendation to make it interesting to the student of central station advancement.



MONTHLY REVIEW OF THE TECHNICAL PRESS

Developments in Electric Incandescent Lamps

By Leon Gaster.

It is my object in this paper to give a short review of some of the most important improvements which came before my notice during this year.

I will start with the improvements of the carbon filament, and bring before your notice the metallized, or as it is also called, the graphitized carbon filament, by the aid of which lamps are made consuming on an average of 2.5 watts per candle, with a useful life of about 600 hours. The earlier lamps were made for candle-powers from 50 candles upwards, but the lamps exhibited to-day are of 16 c.p., consuming only 40 watts. The lamps are manufactured for voltages varying between 100 and 130. They are sold under the name of the "Gem" lamp, and are now being manufactured in this country at Rugby.

Passing on to the Nernst lamp, a recent improvement consists in fitting the lamps with a newly designed cut-out coil of high resistance, and it is claimed that by the use of this coil a great reduction of the premature failures of filaments will be secured. Several improvements remain still to be made in order that the lamp may light up as soon as the switch is turned on. As regards the efficiency of the lamp, no very great further improvement has yet been secured.

Coming now to the metal filament lamps proper, I will refer first to the Osmium lamp, as produced by Dr. Auer von Welsbach. Owing to the expensive nature of the metal used, and partly to the difficulty in manufacture, and bearing in mind the improvements which have since been made by the same inventor, by the use of tungsten, its use is now likely to be restricted to comparatively low voltages.

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The tantalum lamp is only made for voltages up to 125; the high-voltage lamp has not as yet been perfected or brought into the market. The next most important metal used in the manufacture of filaments, and with which much is expected to be accomplished, is certainly tungsten (wolfram). Several methods have been devised for preparing filaments by the use of this metal. One of the first methods was worked out by Dr. H. Kuzel, of Vienna. By his process the metal is obtained in the colloidal state by means of an arc under water. The resulting paste of extremely fine metal is squirted into filaments, which are afterwards heated in order to make them better conductors. The lamps are manufactured in Vienna by Kremenetsky. From such tests as have been made it is ascertained that the lamps consume a little over 1 watt per c.p., with a useful life of about 1,000 hours, with a loss of only 10 to 15 per cent of the initial c.p.

Another method of manufacturing tungsten filament is the joint invention of Dr. Alexander Just and Franz Hanaman, of Vienna. According to their process a carbon filament is electrically raised to a high temperature in an atmosphere of gaseous tungsten or molybdenum compounds. The carbon then becomes coated with metal, and after burning out the carbon, the filament appears quite homogeneous even under the microscope. By another method the metallic powder is prepared by chemical means mixed with an agglutinant, and squirted into the form of filaments, which are then freed from carbon as before. Various other processes have been devised for preparing a paste of the oxide of tungsten, which can be squirted in filaments and afterwards reduced. According to the British Patent 4,814 of 1907, Messrs. Siemens & Halske have devised a process of stamping tungsten powder, sometimes mixed with another metallic powder, but without an agglutinant, in a tube of some metal, which is easily drawn or rolled, such as tantalum or iron. Then, after electrically sealing the ends, they subject the tube to drawing or rolling processes. After the completion of the drawing process the outer skin can, if desired, be removed. This method obviates the necessity for the great care and treatment involved in the ordinary fusing process, but I have not heard whether the method is actually in use. The diameter of some of these metal filaments is very small, lying between 0.05 mm. and 0.03 mm. A filament yielding 60 c.p. at 110 volts requires to be over 600 mm. long. Experiments which attempt the manufacture of filaments of smaller diameters, such as permit the production of lamps of 110 volts and of about 20 c.p., are in progress, and some lamps of such small c.p. and even of high voltages have already been made on a laboratory scale, some of which I am showing here to-day being made in this country at the Robertson Lamp Works in London. The average life of these tungsten lamps for the present can be reckoned to lie between 600 and 700 hours; some lamps have been burning over 2,000 hours.

The next lamp using tungsten, and which is already used commercially, is the "Osram" lamp, and it is the invention also of Dr. Auer von Welsbach. The lamps are for the present manufactured by the Deutsche Gasglühlicht Gesselschaft, and are imported by the General Electric Co., who, I understand, have decided to begin the manufacture of the same in this country. The lamps are made in various sizes up to 100 c.p., and for varying voltages, but the common type which is expected to be used in the near future will be intended for voltages lying between 100 and 130, and of 35, 50, and 100 c.p The lamps burn with an efficiency of 1.2 watts per c.p., having a useful life, on an average, of over 600 hours. The candle-power is well maintained over the whole useful life of the lamp. The lamps are recommended to be burnt for the present with the filament in a vertical plane, and can be equally well used on direct or alternating-current circuits.

The Berlin A. E. G. Co. are also manufacturing a type of tungsten lamp, the process for the manufacture of which has not been divulged, but I am able, through the kindness of their English branch, to show you some of the lamps. They are made for various voltages; the lamp shown yields 50 Hefner c.p. at 100 volts. Turning now to the Zircon-Wolfram lamp, to which I have already referred on more than one occasion, I should like to draw attention to some of the improvements which have been made during the last few months, which certainly represent a great advance over the lamps previously exhibited. You will see, for the first time, I believe, metal filament lamps of voltages above 100, which burn satisfactorily in any position. The filaments are mounted on spring hooks made out of tungstenized carbon, the hooks having the effect of maintaining the filament rigid and in shape, whilst in service, and of preventing the loops from touching, also of allowing of a greater number of filaments in the bulb, and consequently, of reducing their length and that of the lamp. On account of the elasticity of the spring hooks, the breakage of filaments in transit and in service has been reduced.

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Another improvement over the old type of lamp is the adoption of electrical soldering of the filament to the leading-in wires, thus doing away with the inconveniences caused by the use of graphite paste, which was a partial cause of the blackening, the giving off gases, and the defective contacts met with in the previous lamps. The improvement avoids much extra labor, and also the danger of exidation of the filament, if the paste is not very carefully burned away. The electrical soldering process takes place in the open, and an experienced operator can carry out the soldering of about 500 lamps daily. The firm of La Carriere in Paris are the inventors of this spring hook, and I understand that the filaments can now be mechanically mounted in such a manner that the operators do not have to touch them with their fingers, thus reducing the number of breakages in mounting the filaments. The latest type of 110-volt contain only four filaments, of 0.025 mm. diameter, giving out 24 Hefner candles, or for 220-volt 48-candles necessitating only the use of eight filaments. Lamps can also be made of 150 to 200 c.p. to compete with small arc lamps for shop and street lighting. The progress made in this country with the use of this lamp has not been great, but arrangements have been made for a factory to be established in London for the manufacture of filaments, and the subsequent sale of lamp-makers. I may mention that the Zircon-Wolfram lamp was the first metal filament lamp of 200 volts, which I had the privilege of showing in this country, early this year, when discussing Mr. Swinburne's paper at the Institution of Electrical Engineers. To-day I will show you some 220-volt 46-c.p., 46-watt lamps.

Before closing with the series of lamps using tungsten, I should like to show you a Helion lamp, of which very little information is as yet available, although unauthorized extraordinary statements were made regarding the efficiency and performance of this lamp. I think I am the first to have the privilege of showing the lamp in this country, having obtained it from the conjoint inventors, Prof. Parker, of Columbia University, and Mr. Clark, during my recent visit last April and May to the States. The lamp looks like an ordinary carbon incandescent lamp mounted in the same-sized bulb; it is a 100-volt lamp, consuming 35 watts, and gives out 30 c.p. I have had the privilege of seeing, at Prof. Parker's laboratory, the manufacture of the filament, for which silicon is reduced from a gaseous form in combination with carbonaceous gases on the surface of a high-resistance carbon core. The inventors claim that this lamp operates at a high temperature without the carbon and silicon uniting to form carborundum as might be supposed. The silicon shows no tendency to become molten or fluid at the temperature attained. The filament starts with a negative temperature coefficient less than carbon, but at about a red heat the coefficient changes distinctly to positive, and remains so as the temperature is further increased. The efficiency of the lamp is claimed to be 1.2 to 1 watt per candle, or it can run at even less. Although a useful life between 600 and 1,000 hours is claimed, a proper series of life tests could not be made, as there seems to be a difficulty in keeping the joints between the filament and the leading-in wires in good condition. For the proper working of the lamp, it is essential that mercury vapor pumps must be used for obtaining the vacuum, and great care must be taken in selecting the carbon core, so as to obtain homogeneity and purity, otherwise the results are considerably affected. Experiments are now being conducted by the inventors, using as a core, the graphitized (metallized) carbon filament, but I have not as yet heard with what results. The inventors are also experimenting with a special cement for making the joints, and I hear that the results are promising. One of the characteristic features of the lamp is that the length of the filament need not be increased over the ordinary carbon lamp. The filament is very pliable, and there will be no difficulty (when the present defects, which are chiefly of a mechanical character, have been overcome) in making lamps of low and high voltages and of reasonable candle-power. The lamp easily stands transport, and will be just as safe to handle as the ordinary carbon filament lamp of to-day. This is rather an important point, because one of the troubles common to all metal filament lamps at present is their liability to breakage in transport and in handling, particularly so at the hands of the uninitiated consumer. The advantage to be derived from the use of metal filament lamps may often be more than counterbalanced by the expenditure for renewals of lamps, on account of the breakage of the filament.

Iridium has also been used for the manufacture of lamp filaments. According to Gulcher's process, amorphous iridium is made up into a paste by the aid of an organic binding material. The filaments are squeezed from this paste, and are made to glow in the air, and not in a receiver containing air under diminished pressure or indifferent gases. The lamp is only produced for low voltages up to 24, and consumes between 1 and 1.5 watts per candle. Other

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metals, like vanadium, niobium, molybdenum, etc., may also be used in the future, but not much has been made public as yet regarding their use for filaments.

During a visit which I paid to Mr. W. T. Hammer, of New York, I was fortunate enough to see amongst other lamps a few samples of Mr. Heany's invention, some using, I am given to understand, titanium for the filament, and others using a metallic alloy of tungsten and titanium in a dense, shining, coherent state. See U. S. patents No. 839,585 and 842,546. I am given to understand that more will be heard about this lamp shortly.

The economy which can be derived from the use of these new metal filament lamps depends on the price at which the lamps can be sold, the rate of charge for the current used, and the useful life of the lamp, and this is a matter which one must not overlook when tempted to adopt these new lamps for the sake of economy only. The breakage in transport and in handling by dusting or fixing the lamps is a very serious drawback, and to mitigate this evil the lamp-makers will have to work out an arrangement with the consumer so as to reduce the expense to a minimum. The price of the lamp of 100 volts, 50 c.p., is 4s., but there is no doubt that this high price, with an increased output and growing demand, will be greatly reduced in the near future.

Although we have seen that the metal filament lamps can be made of relatively small candle-power at voltages above 100, and of high voltage up to 240, I am given to understand that it is not the intention of most of the manufacturers to sell for the present other lamps than those of high candle-power above 30 c.p., and intended for voltages varying between 100 and 130. This decision has a distinct commercial value, making the change from the carbon filament to the use of metal filaments gradual, so as to be properly appreciated and beneficial to the consumer, manufacturers, and energy suppliers alike. The fact that the high candle-power lamps consume only about one-third or even less energy than generally the present carbon lamps, will, to a very large extent, meet the complaints of the consumer, who, in adopting the lamps, will obtain increased illumination at the same or less energy expenditure than hitherto. It is well known that the carbon incandescent lamps are at present in many cases fixed in a low position, often in the direct angle of vision, and, therefore, detrimental to sight. The reason may be that, on account of the expense at which energy is supplied to the consumer, he could not well afford to enclose the lamps in properly diffusing globes, or to remove them a good distance away from the objects he wishes to be illuminated. With the advent of the new metal filament lamps of relatively high candle-power, the lamp could easily be removed to above the level of the eyes, or enclosed in properly diffusing globes. We should thus obtain good illumination without additional increase of expenditure. I believe, personally, that the high efficiency lamp will prove of inestimable benefit to the consumer, manufacturer and supplier alike. It will bring the electric light within reach of many who have so far hesitated to adopt it, and will render it a cheap and convenient method of lighting. The change from carbon to metal filament must be made gradually. With the extensive use of electricity for lighting purposes, the present suppliers of electric energy will, no doubt, benefit in the long run from the change. For those circuits where high voltage is used, and where it is advisable to introduce the metal filament, resort must be had to series wiring, which, as a whole, is not quite satisfactory, because, as soon as one of the lamps breaks, all the lamps in the circuit go out, and it is not so easy for the ordinary consumer to detect the broken lamp. Several devices have now been introduced to mitigate this drawback. Mr. Dowsing is showing here two of his devices for this purpose. There are also specially devised cut-outs, which act automatically as soon as the lamps break. Where alternating current is used, the voltage can easily be brought down to suit the voltage of the lamps, or auto-transformers similar to those used with arc lamps adopted. In many places on the Continent it has even been found advisable on account of the charges for current being high, to put down motor-generators to reduce the voltage, instead of re-wiring the existing installation.

Speaking generally of the impressions which I received during by recent visit to America, I should like to inform the meeting that very great progress has been made in the recognition of illuminating engineering as a distinct branch of specialization in the engineering profession. I observed an extensive use of successful combinations of shades, lamps and lamp-holders by the aid of which combination the best and most efficient illumination is obtained. The Holophane shades and reflectors seem to be very much used, enabling us to direct the light where it is most wanted, and to produce any desired effect of illumination. I think that this combination of lamp, lamp-holder and reflector forming one suitable unit,

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is worthy of the careful consideration of the lamp-makers in this country.

Having dealt briefly with the improvements made with incandescent metal filaments for general illumination, I should like to draw attention to the progress made in the use of vacuum tubes, and in particular I wish to refer to the Moore vacuum-tube method of illumination.

Two installations have already been erected in London, one outside the Savoy Hotel and another at Salisbury House. The Savoy installation consists of a tube 176 ft. in length, consuming 2,950 watts, using nitrogen gas for producing yellow light. Power factor 70 per cent. The Salisbury House installation consists of a tube 85 ft. in length, consuming 2,200 watts, with a power factor of 60 per cent. A white color is obtained by using CO_2. I am quite satisfied that a useful field will be found for the application of this method of illumination. The use of CO_2 has enabled Mr. Moore to obtain with his tube the nearest approach to daylight yet attained, and I am given to understand that color can be matched in such a light with extreme accuracy. This is certainly a severe test for any method of lighting.

I should also like to draw attention to one fact in connection with illumination, which seems to deserve greater consideration at the hands of manufacturers and large consumers of light, and that is the great value which ought to be attached to the adopting of proper methods of illumination. The advantages to be derived are: first, the sight of the workpeople will be improved and prolonged; secondly, the output will be quite appreciably increased; and, thirdly, which is very important, the quality of the work under proper illumination will be of the same high standard as when done in the daytime. The economies derived by not using proper methods of illumination are false economies when one bears in mind the fact that the expense of providing and keeping up proper illumination is in many cases only a small fraction compared with the value and the nature of the work turned out. This question of defining the proper amount of light necessary for different purposes forms a very useful task for the illuminating engineer.

Before closing, I should like to refer to an American institution, with the work of which I was struck as being of extreme importance for the much needed improvement in lighting, and that is the work of the engineering department of the National Electric Lamp Association. Fifteen lamp-makers in the United States have combined not for the purpose of forming a trust, but with a determined object of improving the quality of its lamps they are manufacturing, and thereby maintaining a proper and high standard. The best evidence of the value of this association is the fact that lamps have been improved during the past few years considerably, and every advantage to the manufacturer has been proved to be an advantage in which the purchaser has shared. Instead of each factory employing imperfectly trained chemists to analyze the chemicals which enter into the manufacture of lamp filaments, a well paid and highly-skilled chemist is employed in a thoroughly equipped laboratory to perform this work, and sufficient resources are put at his disposal to keep on making proper researches, and keep abreast with the latest discoveries. No independent company with a capacity less than about 15 or 20 million lamps a year could possibly afford to maintain an engineering organization which should be in any way compared to the engineering department of the National Electric Lamp Association, and it is only by reason of this association that such an engineering organization can exist. In passing I may also mention, in connection with the necessity of testing incandescent lamps, the beautifully equipped electric testing laboratory which I visited in New York, which is so ably conducted by Dr. C. Sharp. This laboratory is munificently equipped for the purpose of testing lamps for life, candle-power, energy, consumption, etc., securing for the consumers lamps according to the standard specification. It is only by such a central organization and well-equipped laboratory that authoritative and unbiased tests could be carried out. In view of the fact that in this country a standard specification for carbon lamps has been framed, and has come into force on July 1st, I hope before long that such a testing laboratory will also be established in this country, and will receive the proper support of the municipal authorities and companies supplying current for lighting purposes, enabling the consumers to get lamps of really good quality.

Messrs. McKenney & Waterbury Co., 181 Franklin street, Boston, Mass., announce that their new goods are ready for inspection and invite all to an exhibition of lighting fixtures, in gas, electric and oil, for homes and public buildings, not equalled in this country, consisting of chandeliers, brackets and reading lamps, with the latest art glass shade effects.

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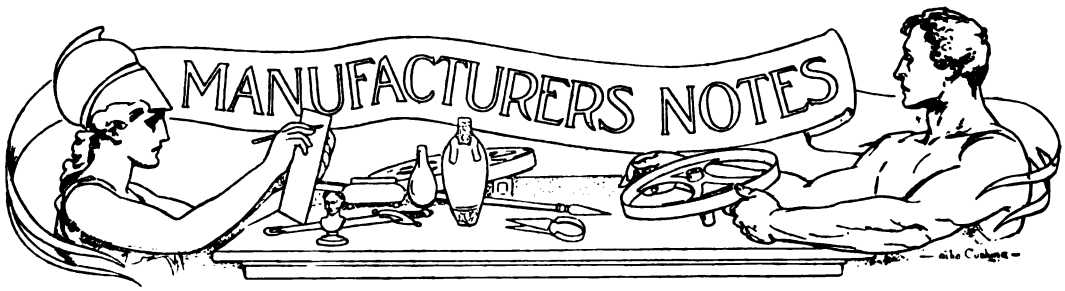

The GEM Filament Lamp

The discovery and introduction of the Gem (or metallized) filament by the General Electric Company, has effected a radical improvement in the quality of incandescent lamps.

The new Gem filament is obtained from the ordinary carbon filament by subjecting it to the intense heat of the electric furnace. This operation (twice repeated) renders the filament much more refractory and capable of withstanding a materially higher temperature for a given life and deterioration. The higher temperature thus permitted gives increased lighting efficiency with a saving of 20% in the current over that required by the ordinary carbon filament lamps to produce a given illumination.

The improvement given by the Gem filament over the carbon filament is graphically shown in Fig. 2 giving the gain in efficiency for the same life, or the gain in life for the same efficiency.

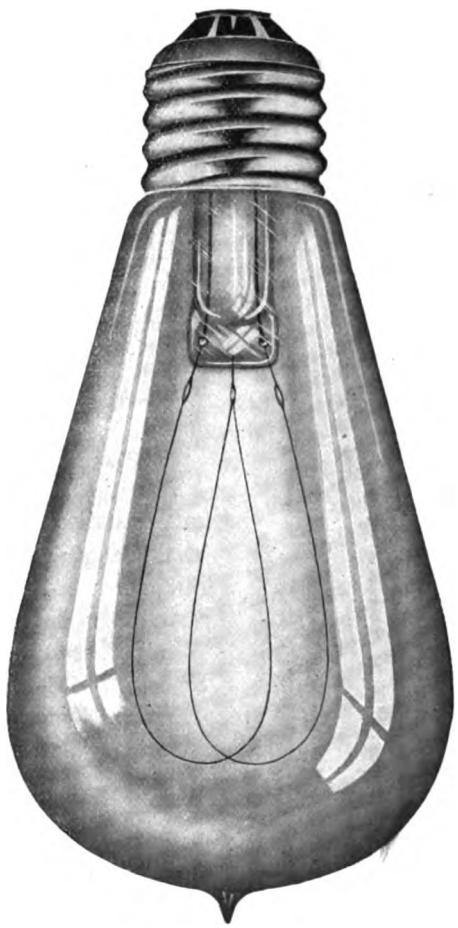

FIG. I.

The standard adopted with the new Gem filament to replace the ordinary 16 c.p. carbon filament lamp is a 50 watt 19 to 20 c.p. lamp. The improvement secured by the Gem filament thus results in a 25% increase of candle-power, with total watts unchanged, instead of keeping the candle-power unchanged and reducing the total watts per lamp. This is considered desirable for the following reasons:

It maintains current consumption per lamp the same as at present.

It gives a higher candle-power which is needed in competition with other illuminants.

Gives consumers the increased light in the lamp instead of necessitating an increase of installation to secure the maximum light obtainable with the same current consumption.

Gives central stations same output per lamp as at present, thus avoiding the necessity of increasing number of consumers or lamps connected per consumer.

The Gem 50-watt lamp, as may be seen from the illustration, is the same as the ordinary 16-c.p. in size of bulb, and in all respects save filament. The Gem filament is made of two loops connected in series. The use of the two loops is necessitated by manufacturing requirements, and

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they are constructed so as to give the same ratio of mean spherical and mean horizontal candle-power as is given by the standard oval 16-c.p. filament.

The Gem filament is somewhat less affected by changes of voltage than the ordinary carbon filament, because the Gem filament behaves like a metal (hence the term "metallized"), in resistance changes, giving an increase of resistance with increase of voltage and decreased resistance with decrease of voltage—just the reverse of the ordinary carbon filament.

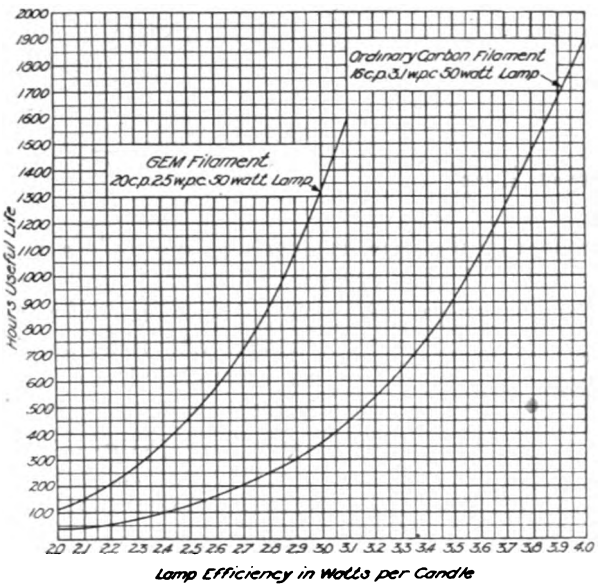
Ordinary Carbon Filament
16c.p. 3.1 w.p.c. 50 watt Lamp
GEM Filament
20c.p. 2.5 w.p.c. 50 watt Lamp
Hours Useful Life
Lamp Efficiency in Watts per Candle

FIG. 2.

The light given by the Gem filament is of superior brilliancy and whiter in color than that of the ordinary carbon filament.

The Gem lamp gives equally satisfactory service on either direct or alternating current circuits, and is supplied for the usual commercial voltages of 90 to 130.

I. P. Frink, of 551 Pearl street, New York City, one of the largest manufacturers of window, store, hall and church reflectors in the world, has equipped nearly every one of New York's largest department stores with the Frink special window reflectors, and among the most recent stores thus equipped are those of Greenhut & Company, John Forsyth, Shepherd, Knapp & Company, and Oppenheim, Collins & Company. These are the newest and largest stores opened recently in New York City. The I. P. Frink reflector catalog No. 54 illustrates, describes and gives prices on these patent window and showcase reflectors, and should be on the desk of every central station manager in the country. They are mailed for the asking.

Dossert & Company, of 242 W. 41st street, New York City, are meeting with tremendous success with the Dossert joint, which is the only joint officially approved by the National Board of Fire Underwriters which, until the advent and perfection of this joint, required every splice in electrical cables to be soldered. The Dossert joint is the only one now on the market which makes a perfect electrical, as well as mechanical splice, without the use of solder, and the unfailing reliability and permanence of such connections caused the changing of the National Electrical Code Rules to admit of its use.

When it is taken into consideration that over 500,000 of these joints are now in use for all sizes of cables, and that not a single complaint has been registered against one of them, it establishes a record not exceeded, if equalled, by any electrical wiring device that has ever been placed upon the market.

The above company has made most interesting exhibits at nearly all the big electrical conventions, and their displays on these occasions have created the greatest interest.

The next exhibit that will be made by this company will be at the coming convention of the American Street and Interurban Railway Manufacturers' Association, to be held on the Steel Pier at Atlantic City, N. J.

The Pittsburg Gage & Supply Co., Pittsburg, Pa., have installed White Star continuous oiling systems in the engine rooms of the Fitchburg Yarn Co., Fitchburg, Mass.; Indianapolis & L Traction Co., Scottsburg, Ind.; Berwind-White Coal Mining Co., Windber, Pa.; Tenn. Coal & Iron & R. R. Co., Ensley, Ala.; Seconnet Mills, Fall River, Mass.; American Sheet & Tin Plate Co., Vandergrift, Pa.; American Bottle Co., Newark, Ohio; Bethlehem Steel Co., S. Bethlehem, Pa.; Diamond Rubber Co., Akron, Ohio. The great saving in lubricating oil, requiring but one handling by human means (from barrel to system), its constant use, being cleaned by the White Star filter after passing through the bearings, and thence used over and over again until actually worn out, renders the use of an oiling system an actual necessity in every up-to-date power plant.

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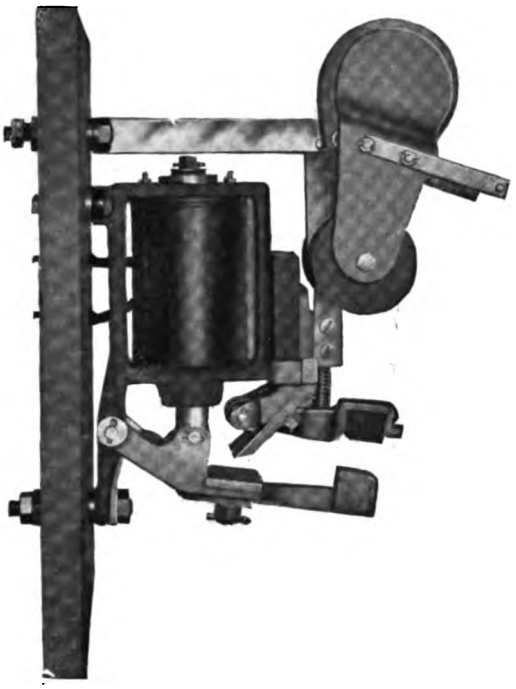
Improved Contactor

The Cutler-Hammer Mfg. Co., of Milwaukee, makers of electric controlling devices, has recently placed on the market an improved type of con-



tactor. These contactors are used for handling main line currents where the nature of the service is severe. In such cases controllers employing sliding contacts cannot be relied upon to handle the main line current, and it is customary to employ a controlling panel consisting of a number of contactors, this panel in turn being controlled by a master controller designed to regulate the secondary current which energizes the solenoids of the contactors.

The improved contactor here illustrated is a compact and strongly constructed piece of apparatus, and is provided with an exceptionally powerful blow-out magnet. The main line circuit is closed by the solenoid raising a pivoted arm carrying a thick copper plate, to a point where contact is made with a pair of stationary, laminated copper brushes. Arcing on this contact is prevented by providing an auxiliary copper and carbon contact in the field of a powerful blow-out magnet, which instantly extinguishes the arc incident to the breaking of the circuit. This auxiliary contact closes before the main contact is made and opens after the main contact is broken, thus effectually preventing any sparking on the main contact.

A noteworthy improvement is the pivoting of the blow-out shields, permitting these to be raised (as shown in illustration), so as to expose the auxiliary carbon and copper contact. In earlier types of contactors these shields were rigidly fastened to their normal position, completely covering the copper and carbon contacts, and rendering access to these difficult. The present construction makes renewal of either contact, or of the coiled spring (visible just above the carbon contact), a matter of a few moments only. At a recent test at one of the largest Pittsburg steel mills a 220-volt circuit was opened and closed by a contactor of this type 88,000 times, before renewal of the copper and carbon contacts became necessary, and—on a test to determine time required for repairs—the old contacts were removed and new ones inserted in less than two minutes.

Growth of the Trumbull Electric Manufacturing Co.

In Plainville, Conn., on February 1, 1899, the Trumbull Electric Manufacturing Company was organized and began business in a very modest manner in the little factory building illustrated herewith. Frank T. Wheeler was elected president; John H. Trumbull, treasurer, and Henry Trumbull secretary. They occupy the same positions to-day, but now conduct an enterprise which is well known wherever electrical switches are used. The young men were practical mechanics, and had invented and perfected inventions of value. The early days were days of struggle and the patents had to be protected.

ORIGINAL TRUMBULL FACTORY.

This took a big part of the capital, but the fight was won, as well as recognition.

The plant and business of this concern has grown rapidly until now its territory not only covers the home country, but the trade-mark, "circle T," representing Trumbull materials, is known in many for-

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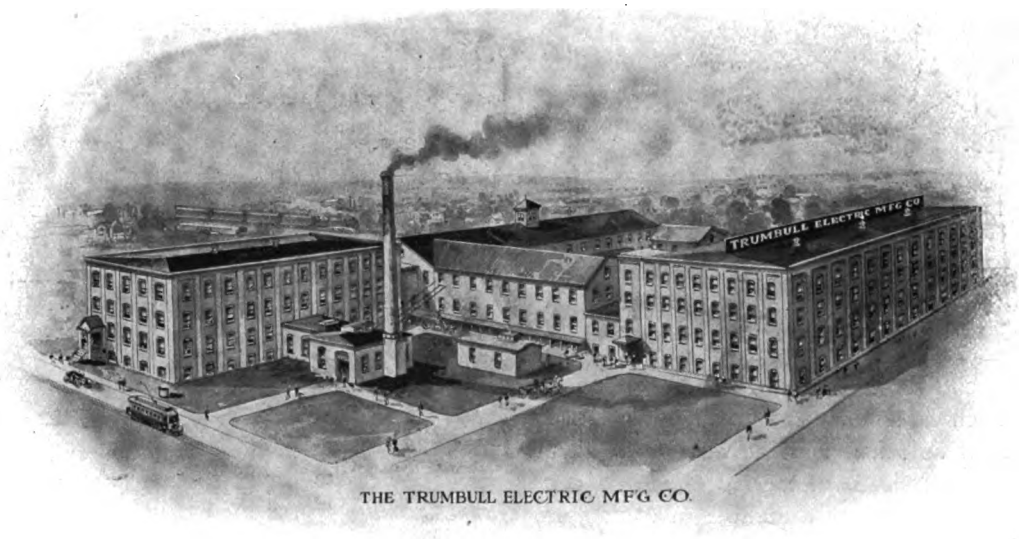
eign countries. The recent completion and occupancy of the new factory building here illustrated has added materially to the equipment and producing capacity of the concern and makes the plant one of the most complete of its kind in the country.

The space originally occupied by the old factory is now used as a storeroom for copper and brass. There is carried on hand a supply of 200,000 pounds of copper and brass alone. In 1901 a building was added to the plant and the manufacture of type B switches was commenced. The second story is used for storing some of the porcelain, and in the attic are kept boxes and miscellaneous material for packing.

The new large factory building just completed is a fine example of the modern mill construction. It about doubles the output capacity of the plant. In the basement is found a large supply of slates of various sizes used in the construction of switches From 150,000 to 200,000 pieces are carried in stock. On the first floor are also machines for drilling the large slate and marble pieces for panel switchboards.

The second floor is devoted to the construction of switchboards and panel boards, and the construc-



THE TRUMBULL FACTORY OF TO-DAY.

A large four-story brick factory was erected a year and a half ago and was promptly outgrown. At the same time there was erected a small brick building in which the enameling of the slate is done. Here the slate or marble, whichever is used in the switchboard work is rubbed and polished. On the first floor of the large building are found the buffing rooms; also the plating and polishing rooms and those where the copper is dipped and lacquered.

The machine room is on the second floor. Here the copper is made into the various different parts. Here also are found a number of diemakers and toolmakers. This company makes practically all its own tools.

The third floor is given over entirely to the assembling of the switches, which at present is the largest line manufactured. The offices are on the fourth floor, and they are equipped with every modern convenience.

tion of the iron boxes in which many of the panel boards are enclosed. The third floor is given over to the assembling of porcelain material, such as combination switches, plug cut-outs, new Code cut-outs, etc. Space is also here given to the cabinet department, where the wood panel boxes of various kinds with the doors and trims are made.

The fourth floor is at present used as a storeroom, but will probably be turned over for the making of the new lines that are contemplated.

The plant has its own sewer system, private wire connections, automatic telephone system and everything necessary for making high-class goods, which has made the concern prominent in the ranks of electrical manufacturers.

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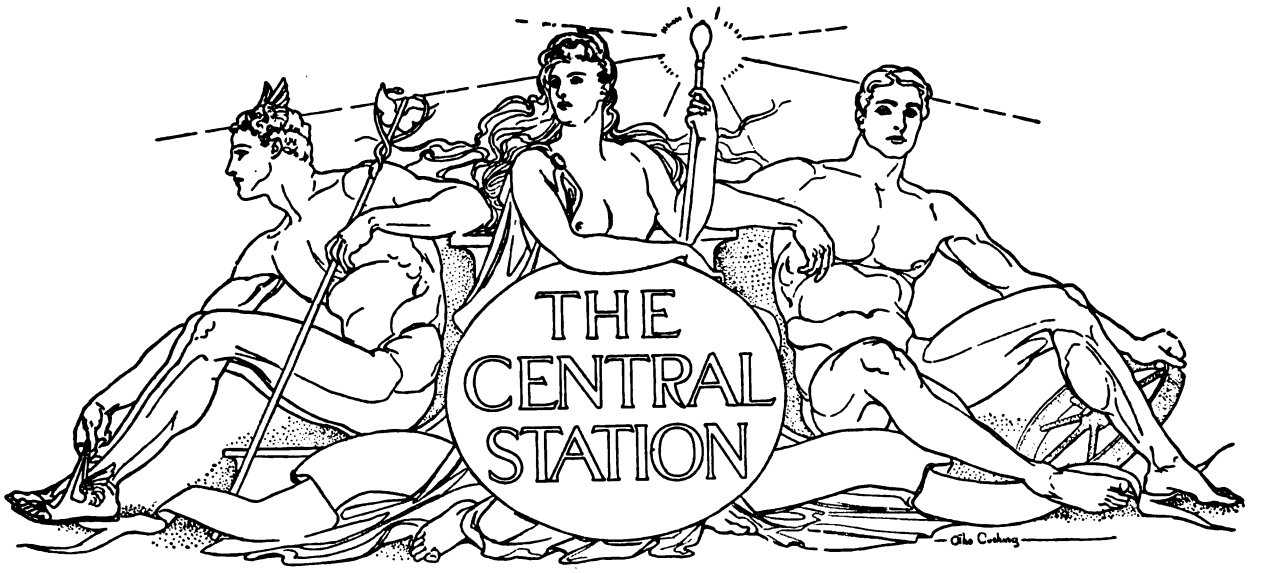

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, No. 5 · NEW YORK, NOVEMBER, 1907. ISSUED MONTHLY.

Central Station Light, Heat and Power Principles

BY NEWTON HARRISON.

Oil Insulation and Water Cooling.—The increase of power transmission plants and the use of very great units of power has led to a redesign of the transformer to meet these new and imperious demands. The use of paraffin oil for insulation is not new, either is the use of water for cooling, but the features of design involved are of direct engineering importance.

The practice now followed out is the use of water cooling tubes in the oil surrounding the transformer. The problems of insulation and cooling are twofold, and serious enough to interfere with this phase of electrical progress unless well solved. At present, the science of construction has developed along lines which call for the use of a special iron sheli of a given surface, and an inner tube system of water circulation.

The conditions are as follows:

1. *Insulation.*—Obtained from a grade of oil that will not gum, deteriorate in insulating power or be unduly inflammable.

2. *Cooling.*—Obtained by means of a metal envelope holding the oil and permitting a free circulation of water by means of an inner tube system.

3. *Capacity.*—Obtained by the use of wire of adequate size to meet the requirements of practice without undue heating. The use of coils of a special construction to reduce the chances of sparking through defects of insulation. Means of securing a low temperature in the coil sections.

Watts Dissipated. — The energy dissipated in transformers is very great according to the records of the largest constructed. The increase in capacity of transformers from 1894 to 1903 are given in the following table:

SIZE OF TRANSFORMERS AND WHERE USED.

1894—100 kw. used at Niagara Falls 3 transformers.
1897—850 kw., 11,000 volts used at Niagara Falls 3 transformers.
1899—1,875 kw., 22,000 volts used at Niagara Falls 7 transformers.
1900—7,250 kw., 22,000 volts used at Niagara Falls 7 transformers.
1902—2,200 kw., 50,000 volts used at Shawinigan Falls 14 transformers.
1903—2,500 kw., 45,000 volts used at Snoqualmie Falls 2 transformers.

The cooling of transformers by special case construction above 500 kw. is not practical. Even up to this point danger arises which is only met and overcome by a skilful design calculated to rapidly remove heat as fast as it develops. In the cases presented, the cooling is not readily accomplished

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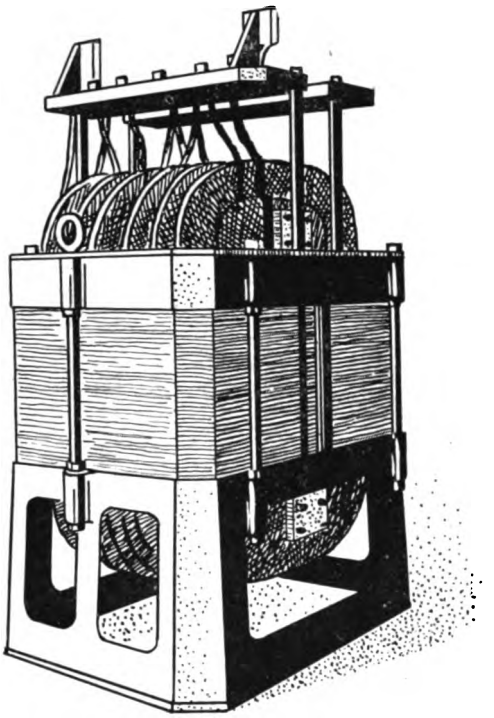
without an excellent water circulation as a brief survey of the power capacities will indicate.

Advantage of Water.—The advantage of water over other fluids is due to its specific heat. It takes 778 foot pounds to raise the temperature of water 1 degree Fahrenheit. On this basis, to raise one pound of water 212 degrees Fahrenheit, would



OIL-INSULATED WATER-COOLED TRANSFORMER.
950 KW.—50,000 VOLTS.

mean the consumption represented by the following values:

$$212 \times 778 = 164{,}936 \text{ foot pounds.}$$

The point presented here is one of vital importance to the power expert. The dissipation of electrical energy in the form of heat is inevitable in transformer design and operation. Calculations make allowances in every case for this loss, while even at a few per cent., under the best of conditions, represents a heavy heat waste.

For instance, a transformer losing 5 kw. in heat would be one of at least 1,000 kw. capacity, perhaps larger. On this supposition, however, the design must be such that the 50 kw. are readily absorbed by the water in a reasonably short space of time. This amount of energy is equal to the following:

50 kw. $\times$ 1,000 = 50,000 watts.

But an electrical horse-power = 746 watts or 550 foot pounds per second. Therefore, the 50,000 watts being equal to

$$\frac{50{,}000}{746} = 65.6 \text{ horse-power.}$$

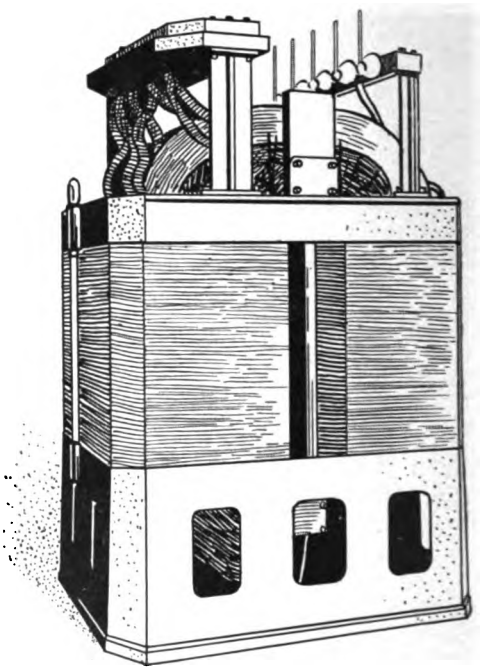
But this would mean an absorption of energy on this basis of

$65.5 \times 550 = 41{,}080$ foot pounds per second.

The energy would not be absorbed so quickly, however, for the reason that the water normally at 60° Fahr., would be allowed to rise to about 150° Fahr., more or less. The rise in temperature would, therefore, be the difference between 150° and 60° or about 90° Fahr.

One pound of water raised through 90° Fahr. would absorb an amount of energy equal to

$$778 \times 90° = 70{,}020 \text{ foot pounds.}$$



OIL-INSULATED WATER-COOLED TRANSFORMER.
2,200 KW.—50,000 VOLTS.

It is impossible to cause this absorption to take place quickly enough to keep the water cool. It slowly but surely heats, dependent upon the amount brought in contact with the energy dissipated as such.

The energy dissipated per minute is greater necessarily in total, though at the same rate. Any other

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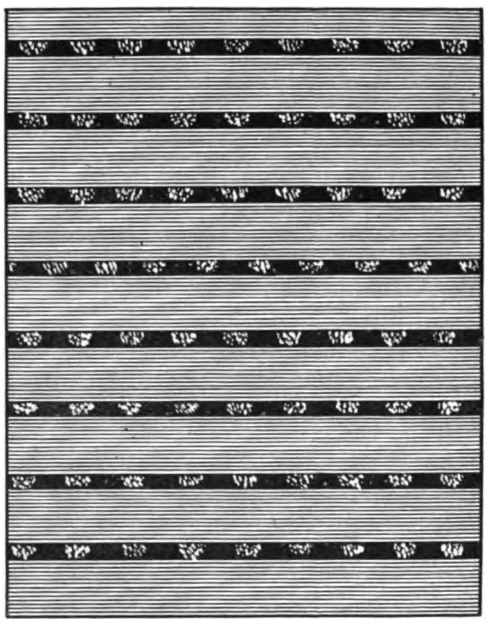
amount of water in pounds would be simply multiplied by 70,020 foot pounds for the temperature rise expressed.

The conclusion reached, therefore, is that water must be circulated in sufficient quantity to keep the temperature down to a given figure consistent with practical requirements.

Absorption of Horse-power.—The 65.6 horse-



CLOSE VIEW OF LAMINATED IRON SHOWING VENTILATING DUCTS.

power wasted by about a thousand kilowatt transformer (the capacity may be greater than this) would equal the following:

41,080 × 60 = 2,464,800 foot pounds per minute. This is the rate per minute at which the transformer would give out energy to be dissipated as heat. But a certain volume and weight of water say, 1,000 cubic feet, would weigh

$$1{,}000 \times 62.5 = 62{,}500 \text{ pounds.}$$

For each degree Fahrenheit this is raised, the foot pound consumption would equal

$$62{,}500 \times 778 = 48{,}625{,}000.$$

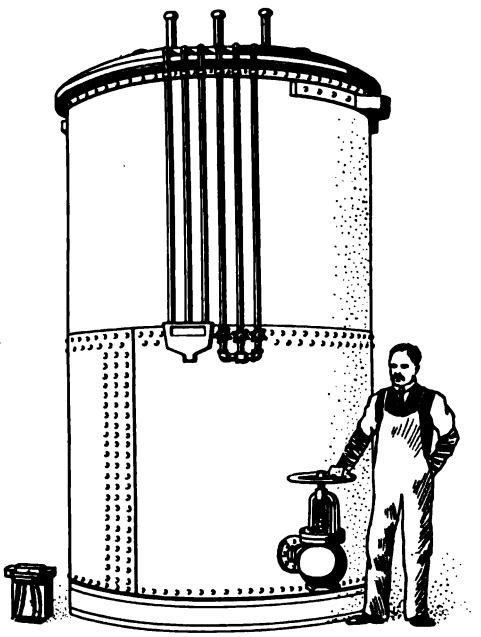
Now the transformer is radiating heat energy steadily at the rate of 2,464,800 foot pounds per minute; therefore, less than 24 minutes is necessary to raise the water one degree at this rate. The heat, it must be understood, is being radiated by the external body of the transformer case as well as by the water. Though the rise of temperature will not be as rapid as that indicated theoretically for this reason, it will eventually take place due to the gradual heating of the wire and metal.

The amount of water circulated in the pipes, if a flow system is employed by pumps or gravity, will not equal 1,000 cubic feet of water, except in a certain time, consequently, a much smaller amount of water is abstracting heat at any instant and the temperature of it will, therefore, rise more rapidly.

Rate of Rise of Temperature.—To make one pound of water pass through 60° Fahr. rise to temperature

$$60 \times 778 = 46{,}680 \text{ foot pounds.}$$

are required. This may not be supplied at that rate by the heat producing coils. Or, in other words, the coils may take many minutes to give out the necessary heat for even a rise of 1° Fahr.



RELATIVE SIZES OF 2,500 KW. OIL-INSULATED WATER-COOLED TRANSFORMER AND SMALL STANDARD ½ KW. TRANSFORMER.

The following table gives values for different weights of water heated through 1° Fahr.

FOR ONE DEGREE FAHR.

1	pound	of	water	.....	46,680	ft.	lbs.	of	energy
5	pounds	"	"	.....	233,400	"	"	"	"
10	"	"	"	.....	460,680	"	"	"	"
20	"	"	"	.....	921,360	"	"	"	"
60	"	"	"	.....	2,764,080	"	"	"	"
80	"	"	"	.....	3,685,440	"	"	"	"
100	"	"	"	.....	4,606,800	"	"	"	"
200	"	"	"	.....	9,213,600	"	"	"	"
500	"	"	"	.....	13,820,400	"	"	"	"

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Flowing Water and Water at Rest.—The lesson to be learned from the foregoing is to the effect that circulating water must keep a transformer cool if it is not pumped *too rapidly.* Time is required to permit it to absorb heat from its surroundings. Therefore, a water system in which the fluid is moved too rapidly, is not as good as one in which it is at rest, provided sufficient is there.

Smaller than 500 kw. are evolved by water by the largest manufacturer of transformers. Sizes as small as 100 kw. are so constructed according to their bulletins.

Sizes of Transformers.—The standard sizes of transformers built for frequencies of 3,000 or 7,200 alternations per minute are as follows:

TRANSFORMER SIZES IN PRACTICE.

Kw.	Kw.	Kw.	Kw.	Kw.
100	200	375	1,000	2,000
125	250	500	1,250	2,500
150	300	750	1,500	3,000

These transformers are built for regular transmission work, the voltages employed varying according to the following table:

HIGH TENSION VOLTAGES.

Volts.	Volts.	Volts.
2,200	16,500	44,000
6,600	22,000	55,000
11,000	33,000	66,000

The plant to be found at Butte, Montana, installed for the Missouri River Power Co., is supplied with 50,000 volt transformers. Other high tension plants may be found throughout the West whose voltages rise higher than 50,000.

Ventilating Ducts.—To increase the radiation of heat as much as possible the laminated iron sections are placed with ventilating ducts between. This form of interior ventilation is highly effective for the following reasons:

1st. They aid in securing an even distribution of heat in the apparatus.

2nd. They tend to preserve a uniform temperature through the whole transformer.

3rd. The oil circulates more freely, thus tending to avoid excessively high internal temperatures.

The Cooling Tubes. The tubes used for keeping the oil cool are coils of seamless brass through which the water circulates. The set of tubes are furnished with valves by means of which the supply of water is regulated. With this means of control, the valves are set to suit the conditions of load, as far as heat is concerned and then may be left to operate indefinitely.

The valves must be so set, that the water, if coming from a pressure source, is not permitted to rush through too hastily. This would prove of little service to the apparatus, and the probabilities are that it would heat unduly in interior parts and become deteriorated.

The rules in construction and use in this case would be:

1st. To have an adequate water supply.

2nd. To limit the rate of flow of the water.

3rd. To use tubes unaffected by the oil or the conditions existing in the transformer.

Coils. The modern method of winding coils for transformers has been reduced to a basis included in the following principles as given by the largest manufacturer:

1st. The total electromotive force of the transformer is divided among many coils, reducing proportionately the strain within an individual coil.

2nd. The electromotive force between layers is reduced to that of a single turn.

3rd. The regulation of the transformer is greatly improved by the interlacing of the coils permitted by this method of construction.

4th. In case of damage to a coil, another may be substituted with little trouble and without returning the transformer to the works.

On the strength of these conclusions, high tension as well as low tension currents are safely handled, and the transformation attended with little or no heat of an abnormal character.

Regulation. According to the manufacturers' statement, the following reasons are given for the practice involved:

1st. The transformer drop occurs twice between generator and the load.

2nd. Because the power factor of such a load is usually low, the drop may be greater than with a more inductive load.

These are the reasons given for close regulation which in oil insulated and water cooled transformers has led to a form of construction in which the coils are so freely interlaced that the drop within them is minimized with either inductive or non-inductive loads.

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Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability to Employee of Telephone Company Injured by Poorly Insulated Wire.

In this case the plaintiff was an employee upon the lines of a telephone company. He had been a foreman, and had experience in the class of work committed to him. In the course of his employment he was required to climb a pole on which were telephone wires, and also highly charged wires of the defendant company. The insulation had been worn from one of the defendant's wires, and the wire had become an object of danger. It appears from the plaintiff's testimony that he approached the pole, in the ordinary course of his employment, walking upon a wall on the side of the road; that it was impossible for him, from the wall, to detect the absence of insulation on the wire, or to see a burnt place which the uninsulated wire had made upon the pole. There is evidence, however, that by going a little distance into the road he might have seen the defective conditions. He did not see them; but proceeded to climb the pole, having his right hand around the pole and sliding it up the pole as he ascended. With his left hand he was preventing the kinking of the cable which other telephone men were running from pole to pole. According to his testimony, he had ascended some 24 or 25 feet when he felt the pole sway as if the men working on the cable had given a sharp pull, and that was the last he knew. A burn was apparent upon the plaintiff's right wrist. His shoe was produced in court, and appeared to have been burned through, under the climbing spur. There was evidence tending to show that the pole was swayed by the pulling of the cable by the telephone linemen.

Plaintiff admitted that he had been instructed generally that, before climbing a pole, he should see that such pole was safe; but he had never worked near this pole before, and his attention had not been called to the defective wire or to the burn on the side of the pole. He had seen other workmen going up and down the pole in safety. He was called upon to climb it in the course of his business. He approached it in the way I have described, and did not, as a matter of fact, see the defects, either before beginning to climb the pole or during his ascent. It is earnestly contended by the defendant that, if he had gone a little distance into the road, he could have seen the defective conditions, and, that if he had been in the exercise of due care during his progress up the pole, he would have seen those conditions.

This was the second trial of the cause. At the first trial the plaintiff obtained a verdict. Judge Brown, the learned judge before whom the case was tried, refused to set that verdict aside as being against the law and the evidence. He did, however, grant a new trial on the ground of excessive damages, unless the plaintiff should remit a certain sum. In refusing to grant a new trial for errors in law, he made a comprehensive reference to the testimony which was before the jury on that trial. He also commented on Chrisholm v. New England Telephone & Telegraph Co., 176 Mass. 125, 57 N. E. 383, and Law v. Central Dist. Printing & Telegraph Co. (C. C.)

140 Fed. 558. I agree with this comment upon those cases, and with his conclusion that it is the duty of the court to leave to the jury the question of due care under the special circumstances of each case. I think it will be seen that this is the only way in which such a case can be passed upon competently, in order to do full justice in the premises. It is true that in railroad cases the dangers upon a railway are so well known that failure to look and listen is, as a matter of law, held to be negligence; but a railroad track is for the purpose of the running of railway trains. The man who approaches it has full knowledge that such is its primary and rightful use; and the use of it by him is subject to its domi-

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nant use. On the other hand, the man who climbs a telephone pole is not charged with knowledge that its rightful use is for uninsulated and dangerous wires. He knows, on the other hand, that there is a duty to keep the wire insulated; and that, while the purpose for which the structures are used renders some dangers from electrical currents unavoidable, he has some reason to expect that the wires will be kept protected. He knows, to be sure, that it is difficult to do this, and that there is liability that there may be a lack of insulation of some wire; but the risk of defective insulation varies with the circumstances, as Judge Brown has pointed out. And the case is not like that of a railroad track, where the danger is always well known, distinct, and incident to its lawful use.

After Judge Brown's decision in the matter of a new trial, this case went to the Circuit Court of Appeals. In speaking for that court, Judge Aldrich said:

"Knowledge that wires are liable to get out of repair, and when out of repair they are dangerous to life, is something entering into the question of care as it applies to both parties. . . . . There is no evidence that he saw the lack of insulation. It is only argued that he ought to have seen it. This being so, and the unforeseen swaying of the pole being the probable cause of the contact, it reasonably, we think, became a question for the jury whether, under all the circumstances, the plaintiff exercised the care of a prudent man in attempting to do what he did."

The testimony upon which the jury found this verdict is not the same as that upon which the Court of Appeals passed in arriving at their conclusion; but, in my opinion, it is not so different as to require a different rule of law. For the purposes of this case, I must assume that the decision which I have cited states the doctrine of the federal courts upon this subject. In accordance with Judge Aldrich's opinion, I think this court must say that the question of due care of the plaintiff in a case like this must properly be left to the jury to decide under the special circumstances of each case. I decline to grant a new trial for error of law.

The defendant contends, also, that the damages are excessive. The date of the injury was August 18, 1905. Before that time the plaintiff was in good physical condition. He has been sick ever since. The evidence shows that he received nearly 2,000 electric volts and fell at least 25 feet, and that from that time he has suffered. He has now the pained and pinched appearance of a sick man. The testimony tends to show that there is still inflammation, that there are adhesions in the vicinity of the liver, and that there is some evidence of neurosis. Some of the evidence indicates a permanent injury. There is, however, a conflict of testimony. One doctor of great skill and learning, of the highest character and of unquestionable honesty, testified that there was nothing the matter with plaintiff which could be attributed to the accident. When he testified, I could see that his testimony did not tend to persuade the jury; but that, on the other hand, it prejudiced them against the witness, on account of the summary and severe view which he expressed, and that it may have influenced them against the defendant. The witness was unquestionably conscientious in his belief; but such belief was contrary to that of the other physicians who testified, and at great variance with the conclusions to which the jury came. It is sometimes the duty of the court to prevent any unfair prejudice from controlling the jury. But in this case the defendant deliberately offered the testimony to which I have alluded. Its prejudicial effect upon the jury cannot be a reason for the court to grant a new trial. While the physician to whom I refer was the only one who testified that the plaintiff was not suffering from the injury which forms the basis of this case, there was much conflict of evidence among the medical men. By his appearance, as well as his testimony, the plaintiff himself induced the belief in the minds of the jury that he had received a painful and permanent injury. From a careful analysis of the testimony, in my opinion, there was evidence from which the jury could fairly find that his injury was permanent. It is the province of a jury to pass upon cases of conflicting evidence. In this case the jury evidently believed the testimony of the plaintiff and his physicians, and did not give credence to the medical testimony offered by the defendant. After a full examination of all the evidence upon this question, I cannot say that the jury have exaggerated the damages; and I conclude that it is not my duty to disturb the verdict. The motion of the defendant for a new trial is denied." Dover v. Gloucester Electric Co., 155 Fed. Rep. 256.

Liability for Death or Injury from Electric Current, Continued—Duty and Liability to the General Public, Continued—General Principles

The case quoted from in the last article is a leading case, another case decided subsequently to this somewhat later in the same year and apparently in ignorance of the former decision came to a some-

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what different conclusion upon the duty of the electric companies to protect the public, this case was Girandi v. Electric Improvement Co., 107 Cal. 120, 40 Pac. 108, 48 Am. St. Rep. 114, 28 L. R. A. 596, April, 1895. In this case the attorneys for the defendant requested the trial court to place its approval by an instruction to the jury upon the proposition of law that "With reference to the use of the agencies of nature, such as fire, steam, gas, or electricity, the court instructs you that persons employing such agencies, and introducing them into cities in the form of commodities for the public use, while held to a considerable degree of care in the service of these dangerous elements, are not required to use such extraordinary care as, while it would render the element absolutely harmless under all conditions, would also render its supply impracticable. The public, who receive the benefits of convenience and comfort from the supply of the commodity, are presumed to know enough of the nature of the element to avoid the dangers which must arise out of its practical use. The duties of the person supplying the community (commodity?) and of the public using it are reciprocal. Each may depend upon the exercise by the other of such ordinary knowledge of the character of the community (commodity?) and such common prudence in its presence as the circumstances of the time and place require." I think this instruction was properly refused.

This the trial court refused to do and the Supreme Court of California approved its refusal saying, "The mere fact that some persons use a dangerous agency raises no presumption that the public know enough of its nature to avoid the danger which must arise from its use; and the public, aside from the consumers using the commodity, owe no duty to those introducing it; but, on the other hand, it is the duty of those making a profit from the use of so dangerous an element as electricity to use the utmost care to prevent injury to any class of people composing the public which exists in any considerable numbers. They must protect those possessing less than ordinary knowledge of the character of the commodity. If ordinary knowledge means that of the person of average intelligence, the rule contended for would leave one-half the community partially unprotected. It is true, when the question is as to the negligence of the defendant, he is entitled to be judged in view of the knowledge generally—that is, almost universally—possessed by the community. The instruction asked had reference only to the alleged contributory negligence of plaintiff. As to that it has been said: "As there are different classes in society, with widely different degrees of intelligence, the plaintiff was not required to exercise more care than is usual under similar circumstances among careful and prudent persons of the class to which he belongs."

The Supreme Court of North Carolina the year before had applied what was essentially the same doctrine in a case where a small boy took hold of a loose wire hanging near the sidewalk and was killed thereby. The court said after stating that the trial judge was requested to instruct the jury that the negligence of the defendant would be presumed. Pretermitting for the present the consideration of the question whether the boy was guilty of contributory negligence in taking hold of the wire, we are brought by this exception to the inquiry, Does the expression "res ipsa loquitur" apply to the state of facts set above, and do these facts make out a prima facie case of negligence against the defendant, and cast upon it the burden of showing that it was not negligent? Argument and authority are not needed to show that those who use the streets of a city, by permission of those who have power to grant such privilege, for purpose of private gain, owe to persons upon such streets the duty of so conducting their business as not to injure them. To speak particularly of the matter now under consideration, the defendant company, using the streets of the city of Raleigh for its purposes, as it was allowed to do, owed to the deceased the duty of keeping out of his way, as he went about his business and to his home, all its wires, and especially the duty of preventing his exposure to contact with any wire placed in the streets by it that carried a current of electricity. It was the duty of the defendant to keep the highway along which it puts its poles and wires substantially in the same condition as to convenience and safety as they were in before it constructed its lines along the streets. Negligence has been said to be a failure of duty. Proof that there was a "live" wire (carrying a deadly current) down in the highway surely raised a presumption that some one had failed in his duty to the public. When to this was added proof that this death-carrying wire was put above the street by the defendant, and was its property, and under the management and control of its servants, and that by contact with that wire the deceased, having a right to be on the street, was killed, a complete prima facie case of negligence was made out, and the burden was cast upon the defendant to show that this live wire was in the street through no fault of its servants and agents. In Aycock v. Raleigh & A. Air Line Rail-

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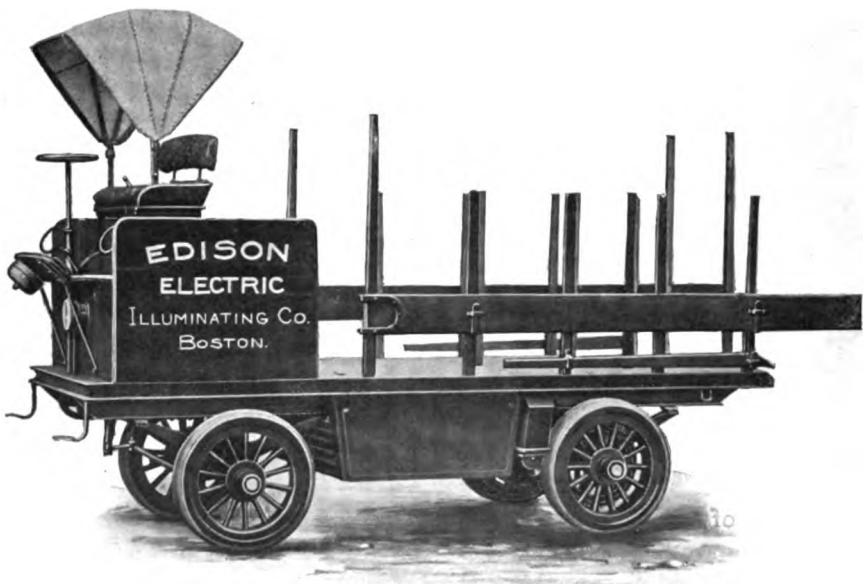
road, 89 N. C. 329, where a plaintiff sought to recover damages for the burning of his property, fire having been communicated to it by sparks from an engine on the defendant's road, Chief Justice Smith, discussing "the question as to the party upon whom rests the burden of proof of the presence or absence of negligence, where only the injury is shown, in case of fire from emitted sparks," declares that this court will "abide by the rule so long understood and acted on in this State, not alone because if its intrinsic merit, but because it is so much easier for those who do the damage to show the exculpating circumstances, if such exist, than it is for the plaintiff to produce proof of positive negligence"; and he adds that "the servants of the company must know and be able to explain the transaction, while the complaining party may not; and it is but just that he should be allowed to say to the company, 'you have burned my property, and, if you are not in default, show it, and escape responsibility.'" This is affirmed in Moore v. Parker, 91 N. C. 275, where it is said that a prima facie case of negligence being thus made out against the defendant, he must produce proof of care on his part, or of some extraordinary accident that rendered care useless, in order to rebut the presumption. Guided by the principle announced in these cases, we come to the conclusion that this plaintiff should have been allowed to say to this defendant: "The wire that you put in the street killed my son while passing along the highway, as he had a right to do. If you are not in default, show it, and escape responsibility."

Haynes v. Raleigh Gas Co., 114 N. C. 203; 26 L. R. A. 810.

The Rapidly Increasing Use of Electric Vehicles in Connection with Central Station Practice

Electric lighting and power stations all over the United States are appreciating the value, economy and almost necessity of dispensing with the old-fashioned, horse-hauled trucks, delivery and repair wagons, and are adopting the electrically propelled vehicles in their places. The modern business methods of gas companies, their active campaigns for the securing of new customers with their improved lighting, heating and cooking devices, has made the managers of electric lighting and power stations "sit up" and take decided notice of affairs, and naturally their attention has turned to the economy, and expediency in handling their product, and the apparatus and supplies necessary in so doing.



HOIST TRUCK: LOAD, 3 TONS; SPEED, 7 MILES; DISTANCE, 30 MILES.

One of the first steps that a progressive central station manager takes is to dispense with stablemen, drivers, horses and cumbersome trucks and wagons, either disposing of the stable property or turning it into modern central station garages for the storing and charging of their lamp delivery wagons, supply

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wagons and trucks for the handling of generators, motors and steam and electrical apparatus connected with their stations.

By the adoption of electrical vehicles, the same service can be obtained with one-fourth the floor space required by horses and wagons, and the employment of stablemen and drivers can be dispensed with for the reason that arc lamp trimmers, or the men detailed in the renewing of customers' incandescent lamps, can fulfil those other duties themselves.

In many cases the necessity of a separate building formerly required as a stable can be dispensed with, and the storage and recharging of one or more electrical vehicles and trucks can be done under the roof of the central station proper, or by a comparatively inexpensive addition thereto.

Between the regular daily trips of the central station trucks or lamp delivery wagons, they may be connected to regular or special switchboards in the generator room for their recharging, and in electric lighting and power stations where alternating current alone is used, the introduction of a mercury arc rectifier will enable such stations to charge their vehicles without the introduction of special direct current apparatus.

The charging hours for such vehicles can be so timed as to take the load from the station after twelve o'clock at night, or during the early morning hours, when the regular commercial load is considerably this side of the peak of the curve. The fact that any slight repair work necessary in connection with the driving gear of electric vehicles can be done by the regular working force of the station, that delivery or emergency wagons are always ready and charged for immediate and instant service, and that the large trucks can be equipped with hoisting motors operated from their own current, are points, aside from their economy, which are the main factors in the rapid adoption of the electric wagon and truck in modern central station practice. The lamp delivery wagon, the hoist-truck and the ladder wagon illustrated in this article are but a few of the many types manufactured by the General Vehicle Co., the largest builders of commercial electrical vehicles in the world. Their extensive works are located in Long Island City, N. Y.

LADDER WAGON: LOAD, 1,000 LBS.; SPEED, 10 MILES; DISTANCE ON ONE CHARGE, 35 MILES.

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High Tension Insulators, from an Engineering and Commercial Standpoint

By C. E. Delafield.

The science of properly and safely insulating line voltages of high potential has not kept pace with the demands of transmission engineers, and to-day we are face to face with the problem of successfully transmitting potentials in excess of 100,000 volts. In California power is transmitted at 60,000 volts more than 200 miles, but great line losses are suffered and the investment in copper is heavy. An increase in voltage from 60,000 to 150,000 would make it possible to deliver this power with reasonable losses and in much greater quantity. As an illustration of the possibilities of delivering power at 150,000 volts, it would be possible to deliver the power generated at Niagara Falls economically to Boston, New York or Philadelphia, and, apparently, the principal hindrance to this consummation at the present time is in the fact that there is not on the market what might be termed a successful insulator for this enormous voltage, although the merits of a number of different types of insulators are at the present time being advocated for this purpose.

The design of an insulator for high voltages—quoting the words of Gerry—should involve a consideration of all of the effects of electrical tension on the dialectrics in the vicinity of the conductors. In the case of a line insulator, air is always a dialectric in combination with wood, porcelain, glass or other materials, and, wherever there it a difference of electrical potential, there exists in the surrounding media a certain state of strain called an electrostatic field. This state of strain is the result of electrical stress applied to the insulating material. It frequently happens, when several dialectric materials are subjected to the same electro-static field, that one or more of the materials will be strained beyond the limit and fail, although the others will stand the electrical tension. Air adjacent to powerful dialectrics frequently fails in this manner, thus giving rise to the well-known brush discharge. The structural failure of air from an engineering standpoint has been studied by a number of investigators, including Dr. C. P. Steinmetz, Dr. F. A. C. Perrine, Prof. Harris J. Ryan, Mr. M. H. Gerry and others, and, as the result of their published investigations, it is well known that air at the ordinary pressures and temperatures has a much lower dialectric value and strength than the common insulating materials. Air in thin films, adjacent to solid bodies, has greater strength than in bulk and is still inferior to such substances as glass and porcelain. The dialectric strength of air is affected by its physical condition and varies directly as the pressure and inversely as the absolute temperature. Under uniform conditions dialectrics rupture at definite applied tensions, Prof. Ryan having shown that there exists for each dialectric material a certain strength of electrostatic field, which will cause a rupture. These being the fundamental rules by which designing engineers formulate their plans for the manufacture of insulators for varying potentials, it can well be seen that the various forms of insulators on the market to-day are the results of working out these rules by different individuals looking at the same thing from a different standpoint. That is to say, climatic and geographical conditions exert considerable influence in the design of an insulator. Insulators suitable for dry atmospheric conditions would not be suitable for a condition where sea fogs and dust exist, and there is no question but what a correct solution will soon be forthcoming for a standard insulator for voltages of 75,000 and upwards. In fact, as noted before, the different manufacturers are now experimenting toward that end.

Looking over the history of high tension transmission, it is only about fifteen years since we looked with wonder on the Lauffen transmission line of 30,000 volts over 100 miles. To-day there are thousands of miles of long distance transmission at voltages ranging from 11,000 to 65,000 volts, and great credit is due the engineers who have designed and carried out this work in the face of almost insurmountable obstacles. The progress of high tension transmission has been very rapid, and in all of the various branches, with the exception of the line insulators, it is now possible to handle voltages in excess of 75,000 volts, there being no difficulty whatever in the designing and manufacturing of successful transformers and switchboard apparatus for these high potentials. It should be taken into consideration, in the future designing and laying out of transmission lines, the possibilty of increasing the present voltage to the voltage that may be possible

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a year or more from now, so that large quantities of power may be economically distributed over long distances.

It has been demonstrated by practice that very large generating units can be successfully operated and that both steam turbine and hydro-electric plants can be operated successfully, and the one question to be decided is, how can large powers that are so successfully generated be distributed over long distances economically, taking into consideration the high price of copper and aluminum. The answer to this question is, by high voltages only. Up to the present time the commonly accepted form of insulator is what is known as the pin type, meaning by that an insulator having for its resting place a pin imbedded in, or fastened to, a cross arm; this pin being of wood or metal. Present practice has demonstrated that wood can be safely accepted for insulator pins up to 25,000 or 30,000 volts. Beyond that it is advisable, for mechanical reasons, to use malleable iron, but the so-called pin type of insulator has reached such dimensions, in the endeavor to meet the requirements for higher voltages, that it seems to be the consensus of opinion of the leading high tension engineers that this type of insulator has reached the limit of good line construction, and, when one stops to think of the dimensions of an insulator used on a 60,000 volt transmission, one is inclined to think that the engineers are correct. Not only is it a difficult matter, from a mechanical standpoint, to find a pin that will take the necessary stress incident to an insulator of this large size and weight, but the problem of manufacture, from the standpoint of the pottery, is one that is exceedingly difficult, so that apparently it is necessary to make a radical departure from the present practice of pin insulation in order to take care of the various difficulties that are encountered in the construction of insulators for the higher voltages, and it is the belief of the writer, and also of other engineers, that a suspended form of insulator will be the type which will be used, it being, from a mechanical standpoint, a comparatively simple matter to suspend any desired weight, and, from an electrical standpoint, it seems possible to so design an insulator that it will be mechanically strong and a good dialectric as well.

The suspended type of insulator would have the advantage that ample arcing distance could be provided without making the insulator top heavy and difficult to manufacture. It should be so designed that arcing cannot occur until the voltage is sufficient to rupture the air and cause the current to arc from end to end, this feature being of great importance where the insulators are mounted on steel towers, which is conceded to be the best engineering practice. On high voltage lines where steel towers are used the pin type of insulator for 100,000 volts, or higher, would seemingly be almost an impossibility, owing to the size necessary to take care of the surges and other line disturbances and owing to the fact that the earth potential is carried into the head of the insulator by the steel pins and through the metal towers.

An ideal insulator, for all conditions of high voltage stress, should be one that would take care of climatic conditions, such as fogs, dust deposits, salt spray, etc., and should have as few still air spaces as possible. That is to say, it should expose a large part of its surface to the wind and should have a long leakage distance of small area. In the designing of a type of porcelain insulator for this class of work, it should be borne in mind that cemented parts, if there are any, should be under compression and not under tension, owing to the strains to which it may be subjected to form expansion and contraction. There should be as few still air spaces as possible to avoid the accumulation of dust, insects, etc., and there should be nothing but porcelain, well vitrified, between the points of opposite potential. Engineers are now at work along these lines, and, as the result, a number of plans have been proposed embodying more or less of these ideas, and it is only a question of a short time before the successful insulator will be evolved for these higher tensions; if it has not already come to pass.

Leaving for the time being the open question of extraordinary potentials, we will take up the question of high tension transmission as it exists to-day. Continuous operation of a transmission system is an absolute essential and depends to a large extent on the effectiveness of the insulator used. In this paper the writer only aims to discuss the qualities of porcelain insulators, as it is now generally conceded that porcelain is superior to glass for the manufacture of high tension insulators, and, in fact, supersedes glass wherever the question of cost is not a paramount problem. In the designing of an insulator for any given voltage, and especially for the higher voltages, there are three considerations of primary importance: First, electrical design; second, the mechanical strength; and third, the quality of the material. In the electrical design consideration must be taken of the dialectric strength of the adjacent air, so that sufficient distance be allowed between the points at which the line voltage is impressed that it will not arc over to the pin or cross

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arm under ordinary working conditions. In other words, make the potential gradient as gradual as possible from line wire to ground. These points of impressed voltage may vary greatly in an insulator of poor manufacture, although of the same electrical design. For instance, in two insulators of the same general design and different manufacture, the one having the greatest electro-static capacity and, therefore, the greatest electro-static field, will suffer from brush discharge and arcing over sooner than one having less electro-static capacity and, therefore, less electro-static field. In another case, two insulators of the same design but of different manufacture, the one possessing a body of greatest density and which is the most vitreous, will carry ordinary working voltages and line disturbances with less trouble than an insulator that does not possess these qualifications.

Due care must be exercised in the manufacture of porcelain insulators to secure the necessary dialectric strength between the tie wire or top groove and the point inside the insulator which is in closest proximity to the head of the pin, providing that pin is made of iron, which is usually the case in voltages in excess of 30,000, and in many cases misfortune has come to the engineer who depended to a large extent on the pin and cross arm for additional insulating qualities. Practice dictates the fact that on the insulator alone should be the reliance of the engineer for his insulation, and all insulators, whether of porcelain or glass, should be tested with approximately three times the full line voltage brought to the inside of the insulator head, and the entire burden of correct and sufficient insulation should be placed on the insulator itself and a large number of line troubles would be prevented.

It has been the unfortunate habit of some engineers to consider the cost of the insulator of paramount importance, and, when one takes into consideration the importance of the insulators to the construction of a line, one is always led to wonder why, by the additional cost of a few cents to each insulator, a reasonable factor of safety is not obtained. It is, however, pleasing to note that many engineers are profiting by the sad experience of their brothers and are securing their insulators based on specifications that insure a reasonable factor of safety, and, in fact, are in some cases going to the other extreme and not only require the manufacturer to guarantee their insulators to stand a rigid test, both before and after erection, but in one case which the writer recently noticed an additional clause was inserted requesting the manufacturers to guarantee that the railroad would not break them in transit, which, we will have to agree, was rather a severe test.

Reverting once more to the electrical design, it is necessary in the design of an insulator that the factor of safety be sufficiently large so that the abnormal electrical strains that may be, and are, occasionally brought to bear, will not cause a puncture and consequently a shut-down of the line. For instance, an insulator designed to carry 50,000 volts should stand a dry test of approximately 150,000 volts, thus giving a fair factor of safety to enable it to withstand the possible surge voltages caused by short circuits, etc. This very fact of requiring a reasonable factor of safety in the electrical and mechanical design of an insulator has decided the limiting possibilities of the pin type of insulator as approximately 60,000 volts line voltage, as, to secure a factor of safety of three, it would be necessary to build an insulator of mammoth proportion and uncertain body, having a weight that is almost prohibitive to pin work. This brings us again to the conclusion that the only method of securing a proper factor of safety on the higher voltages would be to use a suspended type of insulator.

Having discussed the engineering design of a high tension porcelain insulator, the writer thinks it might be of interest to take up its composition and the difficulties of manufacture, concluding with the tests to which all insulators should be submitted before being placed on the line. The porcelain of which a high tension insulator is made is composed of certain proportions of English ball, China clay, some domestic clay, commonly called Tennessee, and some feldspar and quartz. The clay forms the body and gives the proper mechanical strength, while the function of the feldspar and quartz is to act as a flux and thoroughly permeate all the parts of the insulator, thus making a thoroughly vitreous mass when subjected to a sufficient heat. This mixture having gone through the various steps of grinding is forced through a filter of copper or silk cloth of 110 mesh to remove all impurities, and is then formed in the various shapes and designs suitable for the purposes for which it is to be used and placed in the drying room. After a sufficient amount of moisture has been removed in this way the insulators are dipped in the glaze solution and are again placed in the drying room, after which they are placed in the kilns and subjected to a heat approximating 2,700 degrees Fahrenheit. The function of the glaze is to give the insulator the necessary color and also a smooth, even surface, in order that dust

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and rain may be easily dispelled. Ordinary unglazed porcelain would come from the kilns a pure white color with a comparatively rough surface, which would hold the dirt and moisture, so that it is necessary to glaze the insulator in order that a smooth, glassy surface may be obtained, as well as the desired color. If, in baking, the insulator is not subjected to the proper amount of heat the body of the clay will not be thoroughly vitrified. If, on the other hand, the insulator is subjected to too much heat the body of the clay will be porous. Therefore it is necessary that the insulator be subjected to the exact amount of heat necessary to secure the desired results.

In determining the exact amount of heat to which these insulators shall be subjected, ordinary thermometers are not used, but a small carefully prepared cone of pre-determined composition is utilized, which is placed at intervals in the kilns and is observed through small orifices by the attendant. These cones assume an erect position under any degree of heat below the desired one. As soon as the predetermined point has been reached, however, the cones melt and form glaze and at this point the heat is turned off and the ovens allowed to slowly cool, so that the wire may be thoroughly annealed. This process cannot be hastened but takes a certain well-defined time for its operation. When removed from the kiln the insulators are then subjected to a most rigid electrical and mechanical test to determine their qualifications for the work which they are designed to do, and all those not coming up to the specifications should be rejected at this time. A certain number of all insulators coming from the kilns are subjected to two electrical tests, one a dry test to determine the dialectric strength of the porcelain body and the other a precipitation test to determine as nearly as possible the action of the insulator under most severe climatic conditions.

The only objection that has been offered to porcelain as the composition of which the insulator should be made is the fact that in no other way than the above described can a porcelain insulator be properly tested, whereas the defects that might occur in glass can be detected by the eye. Unless an insulator is thoroughly vitreous and is practically non-absorbent and shows a fracture similar to glass, it is unfit for use under high potential stress. An ideal insulator would be one having a minimum amount of electro-static capacity with a maximum amount of mechanical strength, but in the pin type of insulator a strange phenomena exists, inasmuch as it is necessary to sacrifice one condition to some extent to obtain the other good points, and an insulator of successful design is one which appearance shows contains a happy medium.

The Collapsed Quebec Cantilever Bridge

The collapse of the Quebec Cantilever Bridge over the St. Lawrence River between Sidney and St. Romauld, five miles above Quebec, carrying with it the lives of some eighty workmen on the afternoon of August 29th, draws attention to the really remarkable size of this structure and the stupendous engineering undertaking involved.

This bridge, when completed, will have the longest single span in the world, being 675 feet long or 90 feet more than that of the great cantilever bridge over the Firth of Forth, Scotland, which until the present time has been known as the longest span.

The original plans for the structure were prepared in 1851, but it was not until 1898 that the actual work of raising the funds for construction was begun. It took more than forty years of agitation on the part of the business men of Quebec to get the bridge under way.

The point where the crossing over the river is made is 175 miles nearer the sea than the nearest present crossing, the Victoria Bridge, Montreal, and the channel here is 2,000 feet wide and over 200 feet deep. These conditions made necessary the use of the cantilever type of bridge with the unusual span of 1,800 feet. The total length of the bridge is to be 3,220 feet.

There are so many novel features of construction and methods of conducting the work of building this bridge, that, even with the recent serious setback, much has been learned which would otherwise have remained untried. For the first time in the history of bridge erection, electricity has been used exclusively, and with gratifying results, for operating all the hoists, and other machinery. There has been a very apparent absence of smoke, noise and the confusion usual to a large undertaking of this sort.

The electric current for operating all the motors is generated by the hydro-electric plant of the Canadian Electric Light Company at La Chaudiere Falls, three miles from the bridge, and among the units installed there is a 1,000-kw. Allis-Chalmers waterwheel type alternator. This current is transmitted as a 2,400 volt alternating current to motor generator sets installed on the approach span to the bridge, where it is transformed to a 550-volt direct-current and distributed to all parts of the work.

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The Westinghouse Companies

The appointment, on October 25, of receivers for the Westinghouse Electric and Manufacturing Company, the Westinghouse Machine Company, the Westinghouse Lamp Company and the Nernst Lamp Company, under the conditions of the money market at that time, was the only sensible and logical precaution for conserving and protecting the interests of everyone concerned.

The examination of the affairs of the above companies showed the receivers appointed that it was not due to any falling off of the business of these companies, but on the contrary, proved to be nothing more serious than a rapidly growing and profitable business.

The enormous growth of the Westinghouse interests necessarily required the employment of considerable borrowed capital and credit throughout the country, a business procedure resorted to by nearly every other large manufacturing concern, and the sudden withdrawal of this aid, owing to the panicky conditions, seriously interfered with the manufacturing operations, of these perfectly solvent institutions doing the largest and most profitable business in their histories.

Since the appointment of the receivers, the operations of the Westinghouse Companies have gone on exactly as heretofore, and no departure from their general policies has been made or contemplated.

This attitude of the receivers, their reports of the conditions of the companies, together with the acknowledged ability of the men selected to act in this capacity, have already created a feeling of utmost confidence everywhere, and it will be but a short time before they will be warranted in restoring to Mr. Westinghouse and his co-partners these properties which stand as a monument to the genius of the man whose name they bear.

Power Driven Ratchet Rheostats

The principle of evolution is more alive to-day than ever before, if there is anything to be learned from electrical development. The rheostat is passing through changes which have materialized in a unique form of resistance regulator. A word on the subject of these evolutionary changes will prove instructive as well as interesting with respect to so old and well-known a device as a rheostat.

Originally the rheostat was attached conveniently near the fields, which its action controlled. When it was necessary, the dynamo tender regulated the lamp voltage, by adjusting the resistance to a suitable point. The resistance was made of large coils of iron wire in a cage-like box with a regulating handle. The construction has not materially changed to-day, but the position of the rheostat has. The form which employs an enamel insulation and a flat body is very convenient as far as space is concerned. But aside from variations such as this from the main type, the rheostat employed for electric lighting naturally grew larger and larger as the generators increased in size.

The rheostat was attached to the switchboard in such a way that it could be handled conveniently, and the lamp regulation effected.

The enormous generator of central stations at

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present in use led to the construction of huge rheostats whose commutated connections only were led to the switchboard. In order to operate these successfully ratchet devices driven by motors have been installed.

By means of a "simple, compact, electrically-operated remote central station," the ratchet governing the operation of the rheostat is moved to any given point, an equipment of this kind was installed in the Chicago Edison plant. It has proved eminently successful and is the forerunner of a series of innovations of the same character.

The tendency noted in central station work is not only to improve in detail the older devices as far as this is possible, but to introduce a system which tends to center more than ever the operating parts in a given section. A central station in this respect is like a large ocean liner; its nervous system is placed under the hand of the captain as far as possible.

All devices that aid in the accomplishment of this idea are absorbed and utilized. All ancient or time worn devices and methods are necessarily thrown aside. If anything signifies progress, it is the electrical field; and correspondingly, if anything indicates evolution in an industrial sense, of the highest type at that, it is the central station.

Electric Automobiles in Central Station Practice

Automobiles are of various orders and perform varied functions. They enter into the private and public life of great cities in many ways. Among some of the most noted of their applications to particular spheres of work is electric light and power plants or central stations.

The electric automobile in central station service, has a great many striking advantages over the regular truck or wagon commonly employed. This horse-drawn vehicle has been displaced in many cases by the more easily handled and far more economical electric "auto." The emergency wagon, for instances, which is generally kept in waiting with horses attached until needed, is most efficiently displaced by the electrically equipped and electrically driven vehicle.

The horse, in central station service is certainly an anomaly, which is disappearing rapidly from the scene of modern advancement. It is not passing away because either custom or fashion dictate the change; but it is being eliminated solely through the influence, advantage and economy found in the electrically driven vehicle.

For instance, in a truck or emergency wagon, the need of two men is not obligatory; on the contrary, the system of operation, is sufficiently simplified to call for the services and attention of only one man. The range of application of the electric truck, with its full outfit of necessary appliances to meet whatever crisis arises, is greatly increased by its individualization as a distinct, electrically driven, fast moving, ever ready means of reëstablishing or repairing the service.

The lamp wagon is no longer a horse-drawn vehicle; it is a fast moving automobile capable of covering the ground in hot or cold weather with dispatch and cheapness. The saving comes in, where the items of care of horses are generally found. The climatic changes, the cost of veterinary inspection, the age limit of service, the risk of accidents to the horses, the possibility of not being in condition for a run—all of these contribute heavily to the argument in favor of the change to electric power.

For arc lamp trimming, the electric vehicle is the *ne plus ultra* of inventions. Its range, as in the case of the other "electrics," is from 20 to 30 miles and its speed from 7 to 10 miles an hour. These facts speak eloquently of the elasticity of such a system in comparison with the old. The saving in time, the need of only one man, the diminished depreciation of first outlay, the far greater output of work done, the saving in cost of labor and the cleanliness sum up the situation in full.

This theme, of contrasting the old with the new is an ever fruitful one. There are some that believe in the old times and the old ways. There are others that complain about the laxity of personal effort and its reduced accomplishment. To these we would say, to-day is better than yesterday, industrially, financially and commercially. New ideas are flowing into the old rock-bound systems of the past. The central station of to-day consists entirely of new ideas, not only in the machines gathered together under the roof bearing that name, but in the system at present in vogue that represents it.

The use of electricity to extend the range of service of a central station, is the most natural of all things. That this ultra-service is manifested in the form of trucks, emergency wagons, lamp trimming and other vehicles, is a logical development which would have been even theoretically deduced. The central station thus becomes more and more an electrical center, whose functions are dependent upon and performed by the energy which it produces and distributes as light, power and increased range of operation.

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The New Insulator

The new insulator is really the old insulator reconstructed and reapplied. The new requirements have been the means of developing the new insulator to its present point of excellence. The requirements which bind insulator builders to produce a certain type of device for this purpose are: first, strength; second, durability; and third, insulation.

Towers, from which the high tension wires are strung in the most modern installations, are supplied with supports for the wires, which in common with the towers resist the weight and strain they are subjected to.

An insulator, which insulates a 60,000 or 125,000 volt conductor must be of durable and strain-resisting material. It is evident that the problem is none too simple. An insulator which successfully meets the demands of practice is not a product of guesswork or inexperience. These, of all the so-called simple parts of a transmission plant equipment, are now engaging the serious attention of the most capable of engineers.

It might almost be said that transmission of power problems depend upon their solution upon the insulator above all things. The new insulator, therefore, is really the old, but reconstructed to meet the new conditions. It has been rebuilt, of different shape, material and greater strength, to meet the new and severe conditions of practice as exemplified in the use of them for pressures of tens of thousands of volts.

The Mercury Arc Rectifier

Central station practice is such that it embraces more than ever the latest that has arisen in the field. The electric automobile is now used in such numbers that the load resulting from the power consumption its charging represents is a distinct part of the central station output.

At the present rate of increase the vehicular traffic will not slow down, judging by conservative opinions on the subject. The demand for power-driven vehicles is phenomenal, and in this city at least, a fair part of the orders go to the builders of electric autos.

The charging was at one time a problem of the greatest difficulty. To-day it is of minor importance. Where direct current is readily obtainable, little or nothing is said on this basis. But where the central station supplies only alternating current, the charging of electric automobiles assumes a different aspect.

The rotary converter is the machine the central and power stations depend upon for the conversion of large quantities of alternating current power into direct, and the converse. But the requirements of automobile charging stations hardly include such equipments. The demand in each center is not sufficient, and the installations of central station apparatus would not pay.

What, then, is the solution of the problem? As far as the evidence goes, the problem remained unsolved until the arc or mercury rectifier was invented and applied.

The situation, to briefly restate it, was this: The direct current on tap at central stations, or where an adequate service was installed, assisted greatly in the spread of electric carriages of all types. Easy charging meant the very thing the builders had been looking for, in order to encourage purchasers. But the alternating current always represented a stumbling block in those sections where its use prevailed. The mercury arc rectifier so improved the situation with regard to the central station distributing alternating current, that to-day the prevalence of one or the other is immaterial.

To quote, with respect to the rectifier employed to gain these ends, from a communication on the subject: "It is of the type usually installed in garages for the charging of storage batteries, and has a rating of 30 amperes. It is operated on a 220-volt, 40-cycle, alternating-current circuit, and gives 110 volts on the direct current side. . . . When first installed, there was some doubt as to the possibilities of the mercury arc for this service (current for magnets), but we are now satisfied that it is not affected by sudden changes of load and requires no attention.

The idea thus presented is one of the greatest interest to garage proprietors for the reasons stated. Aside from these specialized purposes, however, the use of such a device for a variety of needs is readily evident. Wherever a direct current is useful in place of an alternating, this remarkable tube rectifier finds its place.

The use of a direct-current dynamo just for a limited direct current is thus dispensed with in places where the alternating current prevailed. The installation is limited in cost, scope and its otherwise attendant responsibilities by this device. It thus represents, in all instances where a limited amount of direct current power is required, one of the important inventions of the age.

The rectifier then, has assumed a position in the technic of central station practice as a new part of its minor and detailed equipment. For this reason,

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its operation is one whose extension may be looked forward to in a great many cases. Embodying so much, and meaning so much to particular forms of electrical practice, it necessarily occupies a unique position.

Switchboards equipped with converters operating on this principle are now for sale, and the country side garage, supplied with an alternating current finds no difficulty in charging storage batteries and being of service to a greatly increased list of customers. They are durable devices and therefore are permanent acquisitions to central station practice.

MONTHLY REVIEW OF THE TECHNICAL PRESS

The Dangers of Contact with Electrical Current

In a recent issue of the *Chemiker Zeitung,* Herr Hermann Zipp, lecturer at the Municipal Polytechnic at Cöthen, discusses the danger to human life introduced by accidental contact with an electrical current, and comes to the conclusion that the extent of the injury is not entirely due, as is generally imagined to be the case by non-technical people, to the voltage of the current, but partly or mainly depends on the quantity of electricity which is caused to flow through the human body and upon the parts of the system to which it penetrates. The experiments that have been carried out on the physiological influence of electrical currents show that a part of their effect is due to their electro-chemical action upon the liquids of the body, and part to the injury done to the most important organs by contact with the current of electricity. The following facts have indeed already been established: (1) When a current flows from hand to foot under the worst conditions, that is to say, when a man's boots are thoroughly soaked with water and his hands are damp, the resistance of the human body is on an average 5,000 ohms. (2) When an alternating current of 5 milliamperes with 50 complete alternations per second flows through a person, the effect is sufficiently marked to produce muscular contraction; hence in the author's opinion a current of from 50 to 100 milliamperes must be undoubtedly considered as dangerous to life provided it comes into the neighborhood of the most important organs of the body. In judging of the degree of danger exhibited by any electrical installation, therefore, the investigator has to inquire whether it is possible that a current of such volume can be introduced into the human system from any part of the plant. The chief sources of danger are, of course, a broken conductor, too highly charged a conductor, and the effect of lightning; but the following points have also to be borne in mind, viz., bad insulation or high capacity in items of the plant, and the conversion in a transformer of a high tension current into one of low voltage.

The author accordingly proceeds to discuss the various accidents that have arisen, or are liable to arise, under four sperate headings. (1) Simultaneous contact with both conductors. (2) Contact with only one conductor. (3) Contact with the "charging current" in alternating installations; and (4) Dangers introduced during the reduction in voltage of a current.

1. *Simultaneous Contact with Both Conductors.* —In certain conditions, *e. g.,* a chemical factory or a mine where the atmosphere, etc., is damp a man may be injured by contact with a 110-volt current; be-

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cause his personal resistance, being lowered to 5,000 ohms, as already stated, he may receive a current of 25 milliamperes therefrom. It is even possible in some cases, where the air is loaded with acid vapors, that the conductivity of the human skin may be greater still, so that death may be caused by contact with a current of 110 volts. In practice, however, this circumstance does not involve great risk, because it is more easy to eliminate the dangers attendant upon an electrical plant than those of any other form of machinery. In the reports covering the year 1905 issued by the Prussian "Regierungs und Gewerberäte und Bergbehörden" (Factory and Mining Inspectors), seven fatal cases and two severe accidents caused by electrical currents were mentioned. Two of the fatal cases were due to wilful carelessness; the third was caused by a workman interfering with a transformer; the fourth to a man unnecessarily passing between a switchboard and a high tension transformer; the fifth to a man accidentally making contact between the metal cage of a hand lamp running with an alternating current of 110 volts and a water main, the insulation of the lamp having become defective. (This accident will be referred to again later on). In the sixth case a man slipped when he was erecting a conductor to convey a 130-volt alternating current, and made contact between it and the end of a wire lying on the ground. In the seventh case a man was killed with a 500-volt current. In one of the non-fatal cases a man touched the collector of a 120-volt machine with damp hands, and was rendered speechless for three weeks. The reports of the Prussian mining officials for the year 1905 contain accounts of ten fatal accidents in connection with electrical plants, several of which were due to gross carelessness or want of foresight. In every case where death resulted it was shown that the damp air in the workings underground was a very important factor in the case, lowering the resistance of the human body so much that a current of 220 volts was sufficient to produce death. A very curious accident occurred some years ago in the town of Cöthen. The owner of a bathing establishment, who knew little of electricity, had the idea of installing an electrical bath. He fitted up a pair of electrodes at the two ends of a slipper bath, connected them with the 120-volt alternating circuit of a neighboring supply, and tested the effect upon himself. At the moment of entering the bath he received a shock from head to foot, owing to the resistance of his body being lowered by contact with the water, the effect was instantaneous death.

In a large number of cases simultaneous contact with the two wires of a circuit produces no effect at all, either because the man's skin is dry, and so forms an excellent insulator, or because the current passes without coming near any critical organ. For example, some time ago the writer himself accidentally placed one hand between the two contact pieces of a 1,000-volt transformer in such conditions that the current passed for a distance of about 2 in. through his flesh. The effect was a severe shock to the system and a momentary combustion of the skin, but no further ill effects followed. If, however, the contact had been made with both hands, a current equal to 100 milliamperes would have passed through his system even if his resistance had been as high as 10,000 ohms, and death would have certainly resulted. It is, therefore, clear that arrangements should always be made to prevent the possibility of simultaneous contact with both conductors of a circuit, either by compelling the men to wear rubber shoes and gloves, or preferably, the complete suit of clothing designed by Prof. Artemieff. This consists of a garment woven out of stout linen with a layer of fine copper wire, and is so formed as to enclose the whole body. If a man wearing this clothing makes contact with both high-tension conductors, the current passes *via* the copper wire, and practically none enters his system.*

Special care is required in using portable electrical apparatus, such as hand lamps and motors, when the atmosphere is damp. It is always possible that the insulation of such appliances, especially the boring tools used in mines, may become injured, so that the casing of the motor or the cages of the lamps may receive current—as evidently happened in the fatal case mentioned above. The best method of dealing with such apparatus is to provide the casings and cages with earth wires, but it is necessary to see that the earthing is really effective.

2. *Contact with One Conductor.*—When a man makes personal contact with the two conductors of an electrical circuit simultaneously, nearly always gross carelessness is involved; but it is a much commoner thing for him to touch one of the conductors. Inasmuch as no perfect insulator exists, at every spot where a conductor is supported, some leakage of current to the earth occurs. The amount of leakage at any single insulator is negligibly small, but in a very long circuit, where large numbers of insulators are employed, especially in a damp atmosphere or one charged with acid vapors, the total losses of current are serious. Now, if a man standing on the damp ground touches one of the conductors, a cur-

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rent passes from the wire, through him, to earth, and returns via the numerous insulators of the other conductor; and the greater the number of insulators on the circuit, the more dangerous is the current that enters his body. In this particular case, clearly, it is not the voltage of the current which is of chief importance, but the length of the conductors in the circuit that are supported on insulators. The case mentioned above where a man received a fatal shock by contact with the wire cage of a glow lamp, could only have occurred in an extreme electric system, provided, of course, that the wiring had been done properly. The author has intentionally touched the wires of an alternating electrical circuit about 150 ft. long in which the pressure of the current ranged between 3,000 and 5,000 volts. The insulation of the conductors not being defective, he experienced no ill effects; but had the circuit been several hundred feet longer still, some harm would have been done to him. Hence it follows that arrangements should be made preventing the possibility of contact with a single conductor of any electrical plant, even if the pressure is low, except under such conditions as when a man has his hands or feet properly insulated.

3. *Contact with the "Charging Current" in Alternating Installations.*—When the two coatings of a Leyden jar are connected with the poles of an alternator they receive alternately positive and negative charges, and the quantities of electricity necessary to produce these charges must flow through the wires. The quantities of electricity pulsating in the wires under the conditions mentioned, may be termed "charging currents," and are sufficiently large to be indicated by an amperemeter or, if the Leyden jar is large enough, by causing an incandescent lamp to glow. The larger the size of the Leyden jar, *i. e.*, the condenser, the larger are the amounts of electricity stored in it, and the larger is the charging current. Every conductor of electricity forms such a condenser with the earth; and if a man touches one conductor, his body acts as the wire of the condenser, conveying the charging current to earth. The other coating of the condenser is the untouched conductor, and is obviously connected with the source of alternating current. Hence through the body of the man flow the charging currents of the condenser which is formed of the earth and the second conductor; and if the latter is large enough, that is to say, if the conductor is long enough, the charging current may be of sufficient volume to cause death. This charging current is the chief cause of fatal accidents when contact is made with a single high-pressure wire, because the currents due to faults in insulation, which have been previously discussed, are usually far too small in amount to be of importance. In the particular case now under contemplation the length of the distributing system is far more serious than the voltage; and it may, therefore, be said that every high-pressure installation is dangerous when only one conductor is touched, provided a man's hands or feet are not well insulated. Armored lead cables are especially dangerous, owing to their high capacity, and contact with them is likely to produce worse results than contact with a naked wire.

From what has already been stated, it is evident that, more particularly in cases where the installations are employed in a moist atmosphere, there is danger, not only in simultaneous contact with both conductors, but also in contact with one. Escape of current is particularly liable to occur from badly built switchboards and similar apparatus, although such escape can easily be prevented by proper construction. It is very necessary that new installations or enlargements to existing plants should only be made under the supervision of men who understand the matter thoroughly.

In this connection it may be of interest to quote some figures from the reports of the German factory and mining inspectors for the year 1904. According to this report between 200,000 and 250,000 accidents occurred throughout the Empire in the year under consideration. Of these about 1,000 accidents were fatal, 16 being due to electrical current, and 28 to machinery shafting, etc. The figures relating to accidents in mines are very interesting, as showing how extremely few cases have been due to electricity. Some of the figures quoted in the Government reports for different years are given in the following table:

1899	4	26	394
1900	2	20	403
1901	2	59	431
1902	4	10	391

4. *Dangers of Transformation.*—In this section of his article Herr Zipp briefly refers to the danger experienced by a man who receives a current in the neighborhood of a transformer. As the insulation of a high-tension circuit is much better than that of a low-tension circuit the current which always tends to escape from the former to earth often finds it easier to pass first to the low-tension circuit, and then to earth. If, now, the resistance between a

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low-tension circuit and the earth is 20,000 ohms, and a man, the resistance of whose body is 10,000 ohms, approaches that circuit, he may receive a part of the current which is on its way via the low-tension circuit from the high-tension circuit to the earth. The risks, indeed, are practically the same as those when direct contact with a high-tension circuit is made accidentally.

In a final paragraph the author refers to the very high voltages (namely, such as 100,000 volts), which are not dangerous to man when the frequency of the current is very great, reaching, for example, 100,000 alternations per second; and he ascribes the harmlessness of these Tesla currents to their passage along the outer surface of a conductor, so that when the conductor in question is a human being the critical organs of his body are not affected by them.

In a later issue of the *Chemiker Zeitung*, Dr. H. Danneel, of Friedrichshagen, criticizes certain features of Herr Zipp's article. He takes it for granted that the physiological effect on the human body of an electrical current is due to electrolysis, *i. e.*, to the migration of the ions in the living cells. Hence the only important question is the number of coulombs of current which enter the system, not the number of amperes. He, therefore, regards the harmlessness of Tesla currents as due to the extremely minute quantity of electricity per phase, which causes the alteration in concentration in the cells of the human body to be insignificant. In a brief rejoinder Herr Zipp disputes the accuracy of the purely electrical view propounded by Danneel. As stated in this main article, he attributes much of the effect of an electrical current upon a person to its electro-chemical action, but the influence on the nerve centers—that is to say, the shock produced by the current—must not be neglected; and the magnitude of this shock would appear to be, to some extent, a function of the voltage.—*London Elec. Review.*

CURRENT IDEAS

For Furnishing More Light, Heat and Power from Central Stations

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Establishing Day Circuits in Towns of 10,000 Population and Under

By F. H. Plaice.

The establishment and operation of a day electric service in a city of 10,000 inhabitants and in a village of, say, 1,400 inhabitants, are two separate and distinct propositions, and while there is no question as to the advisability of such a move in the first case, the second one is usually laughed at.

Man is by nature an imitator, and very prone to follow in the way that has been marked out by others; not because it is necessary, but because that path offers the least resistance. The time is not far distant, however, when a universal day service, the same as with gas and water, will be expected, if not demanded, of all electric-service companies, and as a business proposition it is advisable to make this radical innovation at a time of your own choosing. Don't waste your valuable time wondering as to whether you can make the proposition pay, but act at once, and then see to it that you do make it pay. Your customers are as much entitled to a 24-hour service as is the resident in the large city, and on a smaller scale they need it just as much. Give them the opportunity and proper inducements, and they will give you their loyal support.

Our own little field of labor is certainly no exceptional territory, for it is an old German community that is considered by its neighbors as being hopelessly behind the times, and yet it is to-day paying us for electric service at the rate of nearly $8.50 per year for each man, woman and child in the territory covered by our franchise. Don't go into the new undertaking half-heartedly nor with large expectations, for if ever there was a proposition requiring nerve, energy and enthusiasm, it is the building up of a successful electrical enterprise in a small town. Work must be your keynote, 16, 18, 20 hours per day, with the rest of your idle time spent in planning for the morrow. Enthuse others from your own superabundance of enthusiasm and, no matter how dark the outlook, never for one moment falter nor even think of turning back from the enterprise that you have undertaken. Do this, and soon the dark clouds of impossibility will have rolled

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away and your future will show bright before you.

Keep yourself in touch with the world outside, watch the titanic work that is being done in the large cities in the way of new-business getting, and make good use of the examples set. Look over their methods of procedure and take that which you can use to the best advantage. Many of the plans that can be used to good advantage in a large city will be inapplicable to your work, chiefly because of lack of funds. Don't be disappointed at the results that you accomplish. They may seem small and mean as compared with those you read of in larger places, but when you also compare the population of your town with the other the result is very likely to look more favorable. Remember that a $2 customer is as important to a station in a town of 2,000 inhabitants as a $100 customer is to a station in a city of 100,000 inhabitants, and keep this idea ever before you in your work. While the great city company can and does do business on a large scale, you must do it on a small one, and yet your results may be better than theirs.

In inaugurating the new service you should, of course, see to it that your station is arranged to operate as economically as possible, for the conditions will be bad enough at their best. Don't try to operate your day service with an engine large enough to pull your night peak, but install an outfit that will be barely large enough to carry the load that will be used during the day. Such a set will not be overworked, for it will run practically empty the greater portion of the time.

Of course you must advertise. There are many ways of doing this, but the small station must use the greatest care in this matter or they will spend much of their allowance uselessly.

The extensive advertising program that are followed out in large cities are all right where the company can set aside for this one item of expense more money than your gross earnings will amount to, but the small station managers will be wise if they depend more on personal solicitation and less on printer's ink.

Make a practice of installing your service on its merits and let it prove its value by actual demonstration. No method of solicitation is more effective. Do this with installations of all sizes and characters, whether it be a 4-c.p. lamp in some patron's cellar, or a 10, 15 or 20-hp. motor in some small factory whose inefficient engine you wish to displace. Rarely indeed will you be called upon to back out, unless you have grossly underestimated the operating cost; and, by the way, never do this. Better by far disappoint the prospective customer the other way, if you must make an error in your figures; but a first-class solicitor will never make a statement that he is afraid to back up over his signature.

In soliciting for the new service neglect no one, for no prospect is an impossibility. We even have our gas company, which we have practically driven out of the lighting business, down on our probable list for electric lights in their meter-testing department.

Go to your grocers and induce them to place motors on their coffee and spice mills; your butchers on their meat grinders; your saloons on their beer pumps; your telephone company for its ringing generator; your blacksmiths on their blowers, drills and grinders; your printers on their many little machines; your churches on their organs; your housewives on their sewing and washing machines. Get next to the grain elevators, and the dentists. Put a soldering iron into every tin store, and a glue pot into every furniture store. Put an instantaneous water heater into every barber shop and on every bath tub; get a flat-iron into every home, tailor shop and clothing store; place fans everywhere—in stores, saloons, offices, residences, public halls and church auditoriums. Teach your photographer to depend upon you for printing his pictures. Make your service so universal that if you shut down during the dark hours your town will be in absolute darkness, while a day's stoppage will make every factory take a vacation.

If a gasoline or isolated electric plant trespass on your territory, run it out. If the local gas company tries to share the lighting business with you, prove to it by actual demonstration that it is mistaken as to the value of its product for lighting purposes. If another electric company is in the field, combine your forces into one company and stop useless competition. Take the motto of the C. E. D. A. for your own, and "Be-a-Co-operator." Coöperate with each and every one of your customers for the best interests of both. Coöperate with your large and your long-hour customers in the matter of rates. Coöperate with the electrical contractors of your town; your interests are identical. Coöperate with your neighboring stations in the interchange of ideas, and remember that in the present age the coöperator is the one who forges to the front in all lines.

Push the little lighting units, and thereby get in touch with a class of customers that are strangers

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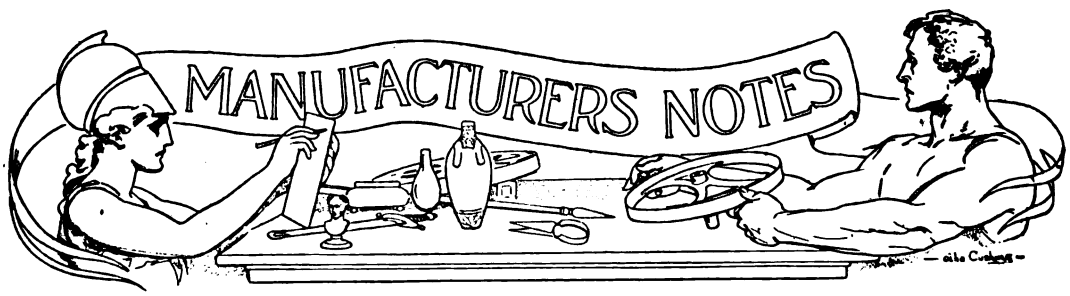
to the average station, namely, the home of the laboring man. Few stations have developed their territory to the point where the competition of the humble coal-oil can has been felt, but sooner or later they will meet this truly gigantic foe.

You cannot meet coal-oil-lamp competition with 16-c.p. lamps, but will have to come down to 4, 6, 8 and 10-c.p. units. Think of lighting a four-room house completely with 24 candle-power in lamps, yet that is not an unusual practice in our town, and from such an installation we derive from $9 to $12 per year. Our efforts against the coal-oil lamp have been appreciated by the great Standard Oil Company to the extent that it felt called upon to send one of its special agents into our town to investigate as to the falling off of its oil sales.

Another thing—don't dead-end your lines when you reach the edge of the corporation, but follow the example set by the telephone companies and build up a rural service. Here is a field that is almost unlimited as to both light and small power service, and yet few companies have recognized the fact. We are now operating about six miles of rural service lines, giving the farmers adjacent thereto a 24-hour service. To these lines we have connected two 15-h.p., one 5-h.p., one 3-h.p., two 2-h.p., three 1-h.p. and several fractional horsepower, in motors, as well as about 150 lamps. The lines are showing good returns on capital invested, and we have found the farmer as a class a very wide-awake and up-to-date person. He can find more ways of making a portable motor useful than any class we have ever had dealings with.

In making all classes of installations we have two methods, either of which is open to the customer. We will either sell the equipment to the user at actual cost or we will rent it to him on a rental basis of one cent per month for each dollar invested in the outfit. These plans will apply, no matter whether it be a one-light installation or a 15-h.p. or 20-h.p. motor outfit. Under these provisions we stand ready to furnish everything that will encourage our customers to make a more extensive use of our service, depending on the increased sale of current to supply us our profit. While the plan has proven very successful with us, we are not prepared to say it is one that could be used in all places, but as a business-getter it is unrivaled Our meter rates carry no minimum, no service charges, no meter rental, and lamps are renewed free. We at all times aim to make our customers absolutely dependent on our service in whatever form they make use of it, and naturally see to it, first of all, that the service rendered is dependable. Be prompt in complying with requests for your service; be tactful; be polite, and see that your subordinates are likewise. Have your business so well in wind that you can tell from memory just how many and what size lamps are installed in any service connection on your lines. Change your lamps often and see to it that they have a margin of overvoltage so that they will not burn red. Lamps that looks like a "hot hairpin in a bottle" are not good solicitors for a lighting company. What the people want is *juice*—plenty of it, and good and hot. In conclusion, we wish to add that in taking advantage of any information, advice, suggestions or experiences, the user should avail himself not only of these, but of the energy and enthusiasm of the originator as well.



Dossert & Company, 242 W. 41st street, New York City, manufacturers of the only officially approved solderless cable connectors, have recently received an order from the New York Edison Company for six hundred Dossert service box plugs. These plugs, a sample of which is illustrated here-

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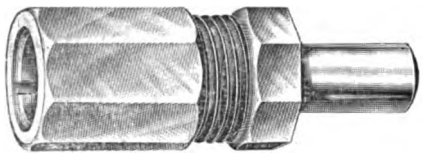
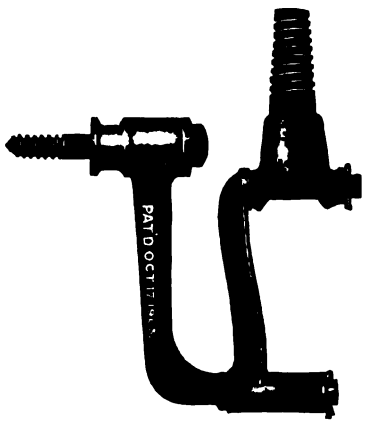
with, are used on the ends of the leading-in wires for service boxes in place of the old style of plug which had to be carefully scraped, dipped and soldered, requiring from five to ten times the time and labor necessary when the Dossert plug is not used.



The above order of the New York Edison Company has been furnished in two sizes for No. 1 and No. 0000 cables.

The Dossert Company has recently furnished the new Singer Building, the highest building in the world, with two thousand of their solderless connectors, which have been specified on the panel and switchboards throughout this new skyscraper.

Dunton & Field, 117 Main street, Cambridge, Mass., have recently added to their tree insulators, which have now become the standard insulators for this class of outside construction, a new attachment



A-5 ATTACHMENT.

known as the A5 Attachment, and is designed for extraordinary cases, to take up the sway of long and thin limbs of trees.

That portion of the insulator which screws into the limb of the tree, as shown in the accompanying cut, is practically the same for all their other styles of insulators, but the swinging arm in the A5 attachment, also shown in the cut, is from two to three times the length of the swinging arm in the other standard tree insulators.

The adoption of the Dunton tree insulator by many of the leading electric lighting and power stations throughout New England has obviated no end of trouble on outside lines formerly caused by the rigid support of insulated feeder wires on trees, without any provision to take up the natural swing of branches.

The above company will send you a little pamphlet describing and illustrating this important article for outside construction if you write them.

The accompanying cut of the November cover of *Trumbull Cheer* illustrates the general two-color design adopted by this "magazinette, published each month if it's lucky," by The Trumbull Electric Mfg. Co., of Plainville, Conn.

The primary object of this publication is, of course, to put forward the new lines of Trumbull

material which are continually offered the trade and to re-emphasize other material already published.

This is done by the publishing of regular price lists with cuts and discounts, and also by articles of more or less technical nature showing forth various

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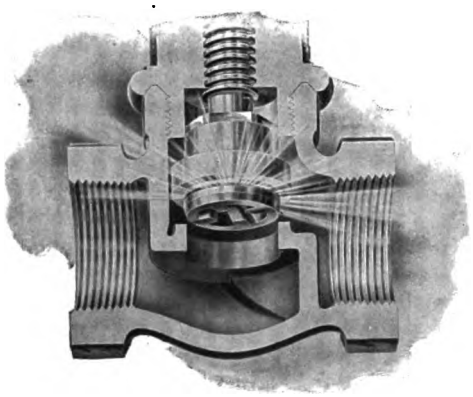
matters arising in the manufacturing field that are of direct interest to the contractor, jobber and purchasing public in general.

In this November issue appears an article on the recent rulings of the underwriters, covering switches for A. C. work, also a detailed list of Trumbull's "A" line of switches showing that prices for 27,840 different Type "A" switches are given in their Bulletin. Their panel boards and switchboards are also advertised.

"Clean-Seat" Valves

The name surely sounds well, and a glance at the sectional views of the valve will show how perfectly the name applies.

In closing the valve, a strong jet of steam (water, air or other fluid) blows directly across the seat and disc faces all the way around, and carries off any sediment or other foreign matter, which might

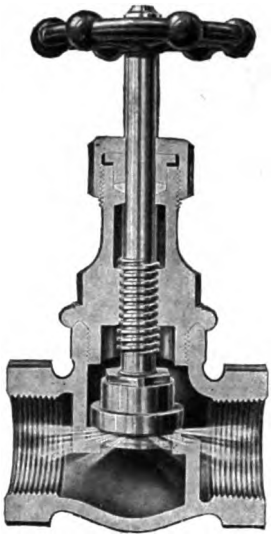


otherwise find lodgment, to prevent tight closing and possibly ruin the seat or disc.

The "clean-seat" feature is extremely simple. A hollow cylindrical extension beneath the disc fits loosely in the seat opening as the valve is closed. Lugs on the inside of this extension afford support when the cylindrical wall is cut entirely through all around by a slot below the disc face. In closing the valve the main flow is throttled when the disc extension enters the seat opening, but through the slot a jet continues to blow across the seat and the disc face until the final closure is complete.

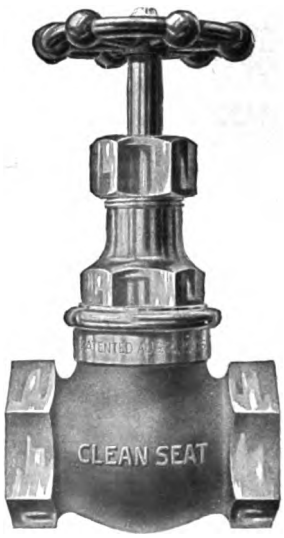
Thrown directly across the meeting surfaces, the cleaning jet cannot cause the cutting action common in other forms of valve when "cracked" or imperfectly closed. The wire drawing of steam through a slightly opened valve of other type causes impinging of the steam current directly against one or both of the meeting faces, resulting in certain destruction by cutting. No regrinding or reseating is necessary in a "Clean-Seat" valve.

The steam may be packed with the valve open,



GLOBE SECTIONAL.

as the top of the valve disc is faved to seat perfectly against the bottom of the bonnet. The bonnet itself is strong, with long thread entering the valve body.



GLOBE EXTERIOR.

The V-joint between bonnet and body insures a tight and strong fit.

"Clean-Seat" valves are made in globe and angle pattern of brass for medium, extra heavy and hydraulic, covering the requirements of all classes of work.

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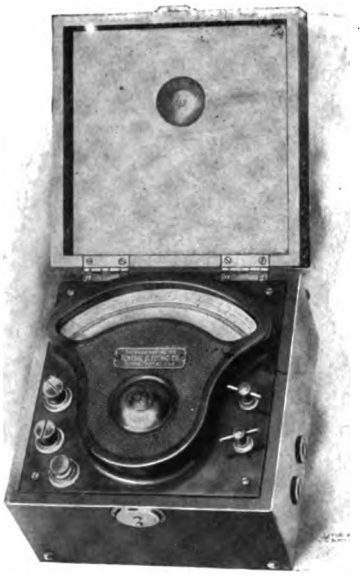
The same principle of construction is also applied to the "Clean-Seat" blow-off valve for boilers, which is also now being placed upon the market by the Pittsburg Gage & Supply Co., of Pittsburg, Pa.

Iron-Clad Portable Instruments

The General Electric Company, Schenectady, N. Y., is now offering a new line of iron-clad portable instruments of a quality that will meet the requirements of the most exacting service.



The voltmeters and wattmeters are constructed on the direct reading dynamometer principle, while in the ammeters the Thompson inclined coil principle is applied. Mechanically these instruments are substantial in construction, with light weight moving element, not susceptible to injury in transportation. The coils of these Type P-3 instruments are entirely surrounded by a laminated iron shield which thoroughly protects from the influence of external magnetic fields. One of the severest tests of the reliability of these instruments when used for laboratory or general testing purposes is their ability to give accurate indications when used in the vicinity of external magnetic fields.

The instruments excel in mechanical construction, are neat in appearance and very substantial. They are contained in wood carrying cases provided with hinged cover and snap lock. By the removal of the internal moulded cover and three additional screws, the entire mechanism can be taken from the case. The binding posts are brought out at the top of the instrument and are provided with suitable thumb screws for securing the leads which connect the instrument to external circuit.

The Type P-3 instruments may be used on circuits of any frequency, wave form or power factor without appreciable error. The voltmeter and wattmeter may be used interchangeably on direct or alternating current. The ammeter although primarily an alternating current instrument may also be used on direct current circuits by taking reverse readings.

The scales of Type P-3 instruments subtend an arc of approximately 90 degrees and are very legible as may be noted by reference to the accompanying illustration.

As portable instruments must first of all be accurate and capable of retaining this accuracy in service especial attention in design details has been devoted to this feature. Careful attention has been given to the construction of the jewels and pivots, as these have great influence upon the continual accuracy of indicating instruments. The pivots are made from the best grade of steel, specially hardened and highly polished, and are suspended in high-grade sapphire jewels which are practically indestructible. The pointer fluctuations are damped by means of Foucoult currents set up in a thin aluminum segment which is attached to the shaft, and oscillates with each movement of the pointer in the field of two astatically arranged permanent magnets. The weight of this segment balances the weight of the pointer, thereby maintaining equilibrium without extra counter weights.

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Type P-3 ammeters are made self-contained in capacities up to and including 30 amperes; voltmeters up to and including 750 volts and single-phase wattmeters in capacities up to and including 30 amperes and 750 volts.

The Northern Engineering Works, of Detroit, Mich., one of the largest manufacturers of overhead traveling cranes in this country, have just received an order for two of their twelve-ton overhead traveling cranes, electrically operated, for the United States Smelting Company, Bingham Junction Plant, Utah. This is the same general type of crane popular in laregr electric lighting and power stations, and used in many of the large electrical manufacturing companies.

Messrs. McKenney & Waterbury Co., 181 Franklin street, corner Congress, Boston, Mass., announce that their new goods are ready for inspection, and invite all to an exhibition of lighting fixtures, in gas, electric and oil, for homes and public buildings, not equaled in this country, consisting of brackets, chandeliers and reading lamps, with the latest art shade effects.

The largest order for alternating current generators ever placed by one interest with any manufacturer of electrical apparatus in this country, has recently been awarded by the United States Steel Corporation to Allis-Chalmers Company, Milwaukee. The Milwaukee Company has received orders for 32 gas engine driven electric generators, aggregating 68,000 kw., 16 of which are to be installed in the new plant at Gary, Indiana, now in course of construction by the Steel Corporation. The other 16 units are for the Homestead Plant of the Carnegie Steel Company, the South Chicago and Bay View (Milwaukee) Works of the Illinois Steel Company, and for the central furnaces of the American Steel & Wire Company, at Cleveland, O.

These are Allis-Chalmers standard type, 25 cycle, 3 phase alternators, and will be direct connected to Allis-Chalmers twin tandem gas engines, operated on blast furnace gas, which is the gas collected at the tops of furnaces and formerly allowed to go to waste.

The use of electrical power in modern steel mills is now extended to cover practically all the machinery of the plant, the systems of telpherage, conveyors and appliances for handling hot metal being now universally driven from individual motors.

At the Gary plant of the Indiana Steel Co., the rail mill will probably require the greatest amount of power. The mill is situated about a half mile from the power house in which the 16 huge units will be housed, and will consume approximately 10,000 kw. to operate the induction motors which drive the main rolls. These motors range in capacity from 2,000 to 6,000 h.p., and three of them have overload capacity of 9,000 h.p. for an hour.

The breaking-down stands in the rail mill for reducing ingots to fair sized blooms, will be driven by two 2,250 h.p. motors. The blooms will then go to the blooming mill, which is operated by one of the 6,000 h.p. motors, and from these they will pass to the mills driven by two 4,500-h.p. motors, receiving their finishing passes in the mill driven by a third 2,500-h.p. motor. All the tilting and feed tables for the various passes, all hot saws. hot and cold pull-ups, the transfer tables, straightening machines and cold saws, and all auxiliary machinery of the mill will be driven by electric motors.

The rapidity with which the steam turbine has come into popular favor is one of the phenomena of modern steam engineering. It is less than a decade ago since the first turbine was sold in the American market, but there are to-day about 700 in use throughout the country, aggregating a total capacity of approximately 1,000,000 kilowatts or about 1,500,000 horse-power. This wonderful demand for that novel prime mover is, of course, easily explained by the many advantages the turbine has over the reciprocating steam engine. An interesting test was conducted recently by the engineers of the New York Edison Company at the Waterside Station near 30th street, which developed facts hitherto unattained by any steam prime mover in this country. The unit under test was a Westinghouse turbine of 10,000 horse-power capacity. It had been sold under a steam consumption guarantee of 15.9 pounds of steam per kilowatt hour, but the test recorded the phenomenally low steam consumption of a shade less than 14.9 pounds per kilowatt hour. Apart from the fact that this result gained a bonus for the Westinghouse turbine of over $25,000, it is of the utmost interest to all users of steam engines as an illustration of the lowest record for steam consumption which has ever been recorded by a stationary steam engine. This steam consumption figures less than 1½ pounds of coal per kilowatt hour and graphically illustrates the great advance in modern power plant practice attained through the introduction of the steam turbine.

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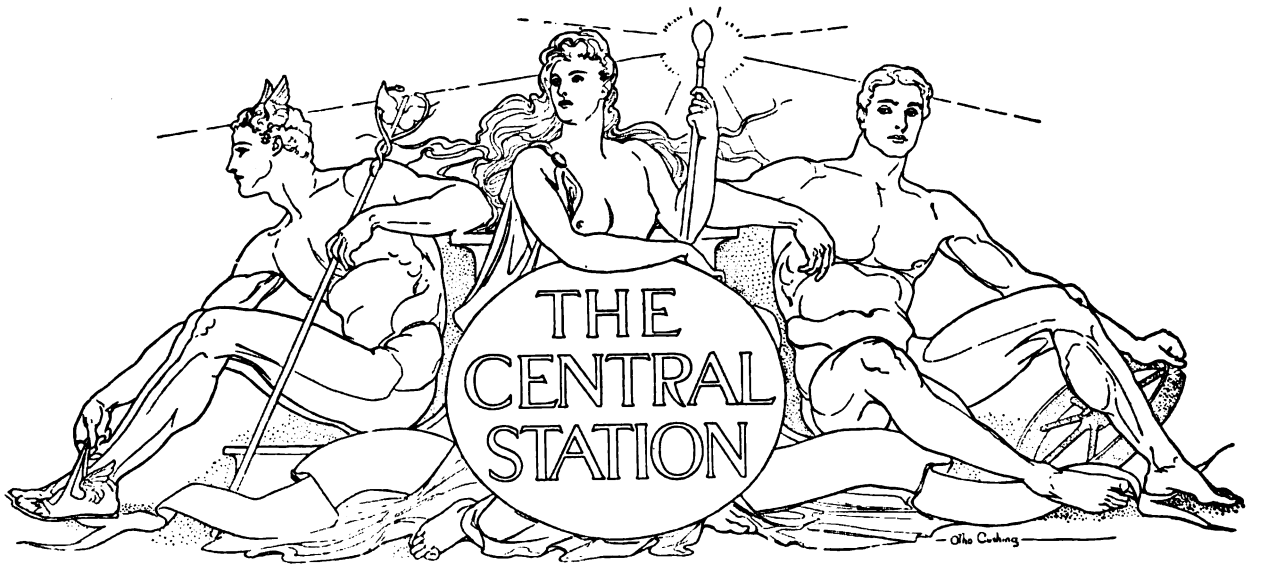

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, NO. 6 NEW YORK, DECEMBER, 1907. ISSUED MONTHLY.

Central Station Light, Heat and Power Principles

BY NEWTON HARRISON.

Foundation of High Illumination.—The construction of modern lamps is based upon certain simple principles derived from an examination of special scientific requirements. These requirements are in themselves derived from the conditions of daily practice, the qualities of materials that are useful in lamp construction, and the limitations imposed by the question of personal risk in the use of a given pressure. Lamps employing a filament are simply cases of where the electrical energy is allowed to act upon a screen of material resisting rapid deterioration under the influence of high temperature. The evolutionary character of the work done to date well illustrates the gradual development of the lamp, to which electricity is applied into its present tube form. The idea may be represented as follows:

1st. The incandescent metal filament in air.

2nd. The incandescent metal filament in a vacuum.

3rd. The incandescent carbon filament in a vacuum.

4th. The incandescent rare oxide filament in air.

5th. The incandescent metal vapor lamp in tube form.

6th. The heatless vacuum tube lamp.

In all of these devices, while the ultimate object was the production of light, the ways of obtaining this purpose were devious. If the statement is not regarded as too sweeping in character, the fact that all methods of lighting are simply efforts to impress a certain amount of energy upon a light giving medium or screen will meet every case. From this standpoint it is evident that the material of which the screen or medium is composed will have a great influence upon the resulting efficiency. If the screen or medium expresses a condition such that the temperature is limited, then the amount of energy ordinarily absorbed to reach a good light-giving temperature is wasted, in that the resulting temperature does not yield much light. On the other hand, if the medium can stand a very high temperature, then the comparatively large amount of light thrown off, is due to but a slight addition to the energy producing less light. The rare oxide lamp enjoys this reputation, namely, as being a lamp in which a higher temperature yields a much greater amount of light with practically no more energy than that consumed in lower temperature lamps. Dispensing altogether with filaments, and using a gas or vapor, the mercury vapor lamp appears as a logical se-

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quence to previous experiments. It employs a screen of incandescent metallic vapor instead of a solid medium to give light. The so-called vacuum tube lamp is a similar instance of where a screen is employed, composed of comparatively few air particles in a vacuum in the first type and a gas in the second commercial form now used. The striking and rebound of the molecules under the influence of electrification, causes incandescence without heat of any importance. Here it is evident that the screen upon which the energy operates is one in which the endeavor is made to avoid the intermediate step in light making, namely, the temperature.

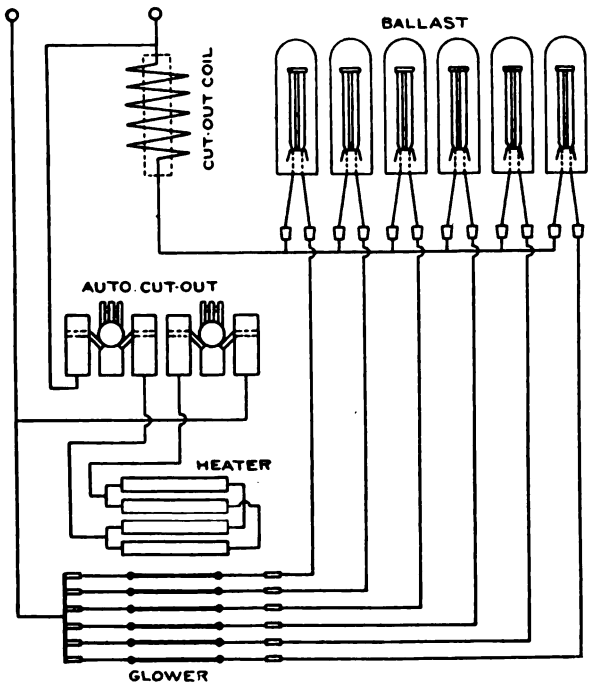
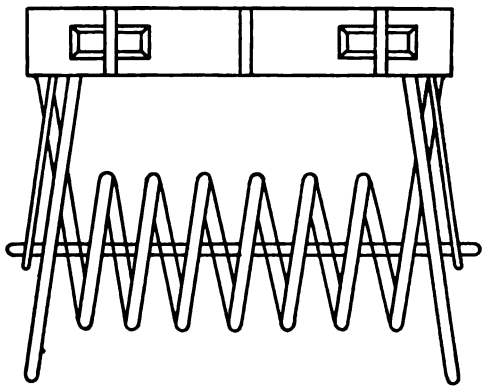


DIAGRAM OF CONNECTIONS OF A SIX-GLOWER LAMP.

Glower Lamps.—Nernst is credited with the invention of the first practical rare oxide high temperature lamp. It simply consists of a rod of badly conducting rare oxide material, made up in the form of a paste originally, and then forced through a die to give it its shape. This is called the glower and is supplied with platinum terminals to make contact with the circuit. The rare oxide rod is non-conducting when cold and in consequence must be heated before it can conduct current and give light. For this reason it becomes necessary to contrive a heater for the lamp. The heater is made to work automatically when the light is turned on. Because these physical conditions tend to increase the conductivity of the glower with an increase in temperature, the use of resistance is necessary. Resistances of this kind are of iron protected from the air in hydrogen filled bulbs. They are given the name of ballast or ballast resistances. The constituents of the glower lamp when enumerated consist of the following:



A SINGLE GLOWER AND HEATING SPIRAL.

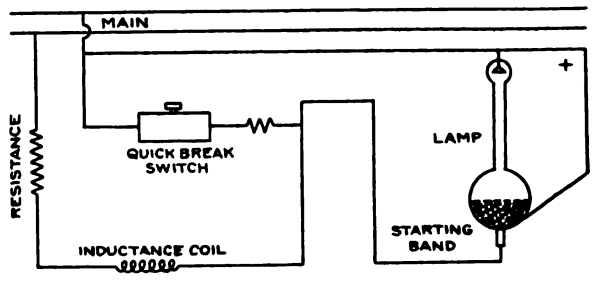
1st. The rare oxide rod or glower which gives the light at a high temperature.

2nd. The heater for raising the temperature of the rod when it is to take current.

3rd. The automatic cut-out for the heater after it has done its work.

4th. The iron wire ballast contained in a tube of gas which regulates the amount of current.

The hydrogen gas employed in the ballast bulb is a more rapid conductor of heat than other gases whose use seems possible. These lamps are made to fit an incandescent lamp socket and are built up as follows:- The smaller lamps are composed of only one glower; the larger lamps consist of six glowers and may be hung up for illuminative purposes the same as any other large lamp. The ballast resistance is simply connected in series with the glower. The resistance of both the ballast and glower as-



CONNECTIONS WITH THE QUICK-BREAK METHOD.

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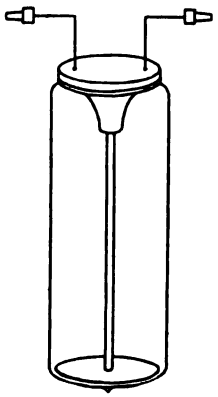
sume a certain value when the lamp is burning. This value limits the current to just the amount necessary to permit it to give its full quota of light. The standard makes of Nernst lamps possess a glower which takes about 220 volts, is one inch in

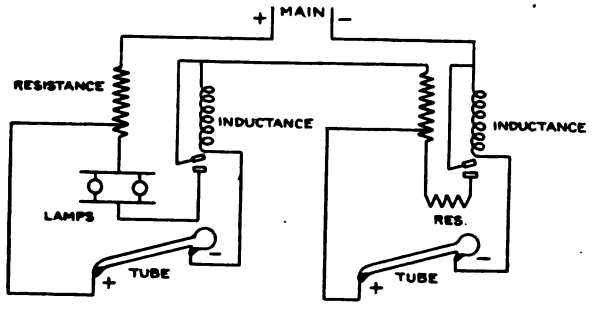


FINE IRON WIRE BALLAST.

length, and about 1/40 of an inch in diameter. The temperature at which the light is given varies from 1,200 degrees F. to 1,400 degrees F., depending upon the current. A fair average is 1,300 degrees F., at which temperature the normal light appears.

The candle-power tests give results as follows: A two glower, 220-volt lamp gave about 70 c.p. with a watt consumption of about 170, or about 2.5 watts per candle-power. The light given out during the life of the lamp is very white and agreeable to the eyes when passed through sand blasted globes.

The glower lamp needs no vacuum for the obvious reason that the filament cannot consume in the air. But if enclosed in a vacuum, then the absence of air means a higher temperature and a lower

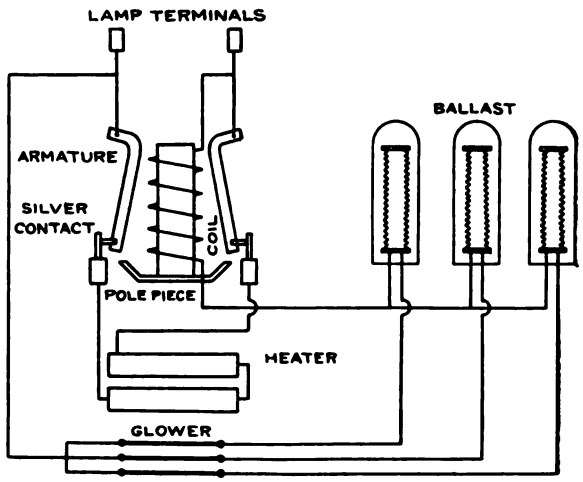


TWO TUBES IN SERIES WITH A 110-VOLT CIRCUIT.

resistance. In consequence more ballast is required to cut down the current, so the efficiency is not advanced to any remarkable extent by this method. As far as the general power consumption per candle-power is concerned, the carbon filament as compared with the filament of Nernst is about one-half as efficient. The entire gain, as previously stated, is due to a high temperature, by means of which the medium produces more light rays.

Comparison of Other Light Sources.—The physical effect of light is, of course, that felt by the eye. The principal sources of light, beginning with the sun, which is the most intense light known, are grouped as follows:

Sun at noon	500,000	72,000,000
Arc Lamp	100,000	14,400,000
Oxyhydrogen Light.	5,000	720,000
Nernst Lamp	1,000	144,000
Incandescent Lamp..	300	43,200
Acetylene Lamp	100	14,400
Welsbach Lamp	25	3,600
Gas Lamp	10	1,400
Kerosene Lamp	8	1,152
Candle Lamp	4	576



AUTOMATIC DEVICE FOR STARTING THE HEATER.

The figures thus given while not absolutely correct, are still a fair average of the correct candle-powers. Experiments conducted with a screen of white material and lamps of the character given produce curious results. The oxyhydrogen light, placed on the screen beside the light from an arc lamp, appear a dull yellow color. In the same manner the acetylene flame sends out a poor kind of light when thus compared. The arc light when projected on the screen, appears dull in comparison with intense sunlight. The eye is not the most reliable means of comparison, however, because it readily tires and thus fails as a critic. The absorbing qualities of differently colored materials with regard to light, might be compared with the action of absorbent bodies of various degrees of porosity. White

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paper, for instance, throws off nearly all the light falling upon it; whereas dark material, such as black paper or black velvet, for instance, absorbs nearly all the light received. The table covering this situation would appear as follows:

Kind of Material.	Percentage of Light Absorbed.	Percentage of Light Cast Off.
White Paper	18	82
Yellow Paper	40	60
Pink Paper	64	36
Blue Paper	75	36
Red Paper	88	12
Dark Green Paper	88	12
Black Paper	95	5

The subject of optics and light mixtures occupies an important place in the consideration of commercial light sources. The reason for this is found in the refusal on the part of the public to endure light that is not pleasant to the eyes and senses. In other words, the nervous system is responsive to the effects of certain forms of light, such forms, for instance, where the preponderance of certain light waves over others is productive of unusual color relationship.

The Mercury Vapor Lamp.—In this lamp the red ray is not present when it operates, and in consequence the color relationship to which the eye is accustomed is missing. The lamp invented by Cooper Hewitt, bearing the title of the mercury vapor lamp, as its name implies, makes use of the incandescent vapor of mercury for its illumination. A long glass tube is exhausted of air, and an electrode attached to one end. This electrode which may be either iron or mercury, transfers the electrical energy to the other lower electrode at the bottom of the tube composed entirely of mercury. The lamp is thus something like a gigantic thermometer with an upper electrode. The action begins when the circuit is established by means of mercury vapor. In practice this is accomplished by means of a high tension spark which jumps between the electrodes. To obtain this spark, it is necessary to provide a powerful inductance coil by means of which a quick break sends the spark across.

Another way of starting the tube is to tilt it until the mercury forms a stream from electrode to electrode and then permit it to resume its original position. Sufficient incandescent vapor will form to bridge the two electrodes and make the light-giving screen required. The use of direct current has imposed some limitations upon its general application, but that does not otherwise interfere with its increasing field of serviceability. The tube data may be stated as follows:

1. Length of the tube, 43 inches for 100 volts, 49 inches for 120 volts.
2. Total length, 50 inches for 100 volts, 56 inches for 120 volts.
3. Diameter, 1 inch.
4. Current, from 3 to 3½ amperes.
5. Candle-power, between 650 and 750.
6. Life about 1,600 hours.

Method of Starting and Connecting Up.—The practical facts in connection with this new source of illumination necessarily relate to its installation and connection to the electric light mains. In the sketches, the following conditions are imposed: First, the lamp is started by the inductive device for throwing a spark from electrode to electrode; second, the two lower voltage lamps are set into operation by tipping and are shown in series on a 110-volt circuit. The use of the quick-break switch in conjunction with the self-induction coil is illustrated readily in practice by starting an arc between two carbon rods by means of the electromagnetic discharge of a coil across terminals composed of such carbon rods.

Here, with the mercury lamp, the high resistance path is bridged readily by means of mercurial vapor and it is then a simple matter to understand the continuation of the phenomenon. The entire principle is that of continuing an arc of mercury between two terminals in a vacuum. The starting circuit is not in use after the arc starts within the tube.

Efficiency of Tube.—The amount of candle-power produced equals 750 and the power consumed equals about 400 watts. On this basis the watt consumption per candle-power equals 750, divided by 400 equals 1.875 c.p. per watt, or conversely, a little more than one-half a watt per candle-power.

The incandescent lamp does not show figures as high as this, neither does the Nernst lamp. The presence of red rays would mean the universal application of this device wherever lighting is done. Their absence limits its use to docks, large lots, factories and places where the color problem plays no part of importance. The suggestion once advanced that the tube be made of red glass to supply the missing rays would mean darkness instead of light. As there are no red rays in the light, and as none but red rays can pass through red glass, it is obvious that no light would penetrate the walls of the tube. The only remedy is to provide a means

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of developing red rays in the tube itself by the introduction of another element, or a modification of the method.

Vacuum Tube Lighting.—Exhausted tubes supplied with electrodes, and a high tension alternating current developing light within them represent the elements of this system. The present commercial development calls for the use of certain gases within the tube. By means of them, certain well-defined tints are given to the light produced. In other respects, the system simply consists of a means by which a high-potential discharge is sent through the tube with more or less ease depending upon the nature of the gas enclosed and the degree to which rarefaction has been carried out. The candle-power is measured per inch or foot of tube and it is claimed that the light thus produced, being more agreeable and better diffused than in a single brilliant center of light, becomes more efficient in the long run. The tubes of 100 or 150 feet in length are greatly in use and indications point to a further development in this field of lighting which may, perhaps, make it a part of many home equipments in the near future.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability for Death or Injury from Electric Current Continued—Duty and Liability to the General Public—Wires in Highways

Some fundamental cases laying down the general rule of the liability of those who make use of or supply the electric current have been considered and the conclusion has been reached that a very high degree of care is exacted of them by the law in practically all jurisdictions. That there is a want of unanimity among the decisions rendering it impossible to lay down a rule which will be true everywhere. The fairest rule and the one which has met with the most general support is that the care used by the light or power company must be commensurate with the danger arising from the agency employed. And this rule means in effect that where the tension is high and the liability to interference is great precautions must be taken such as reasonable prudence would dictate under the circumstances and this amounts to very little more than the ordinary rule in negligence cases; the only difference being in that the courts have regarded the agency employed as one of such peculiar hazard that the only care commensurate with the danger is a high degree of care.

Liability of Owner of the Wires.—Generally speaking, the one who owns the wire which causes the injury is liable, therefore the only exception to this rule arises when there was any connivance of the owner, and third persons have interfered or when because of a combination of wrong doing between the owner and some third person they become joint wrong doers and therefore jointly liable.

The question as to this liability in the last analysis becomes an inquiry into the negligence of the person charged with the duty of maintaining the wires so that injury cannot arise therefrom, and the absence or presence of this negligence has been made to depend upon circumstances such as unusual and unprecedented storms, latent defects in standard apparatus, want of knowledge of the defects, or of facts from which the law will presume notice of dangerous conditions and the like.

Thus it has been held that an electric company is only bound to remove or repair wires in streets after reasonable notice that there is necessity for such removal or repair:

Hand vs. Central Pa. Telp., etc., Co., 1 Lack. Leg. News 351.

So likewise when the devices used for breaking the circuit when the conductor falls to the ground, are not in order so that one coming near the con-

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ductor receives a shock from the earth, negligence is imputable to the company and it may be held liable for injuries sustained.

O'Flagherty vs. Nassau Electric Co., 54 N. Y. Supp. 96, 34 App. Div., 74.

In Wehner vs. Lagerfelt 27 Texas Civ. App. 520, 66 S. W. Rep. 221, the defendants Wehner & White maintained an electric wire along the side of the street. This was insulated. Below it and near to it and suspending from the same poles was a smaller uninsulated wire which had become broken and hung suspending to within a couple of feet of the ground near the sidewalk, the insulation on the electric conductor had become worn away and a small bail wire hung from one of the abrasions and was in contact with the uninsulated wire. The conductor carried a very strong current of electricity and these conditions had existed for two weeks prior to the injury to the complainant, a little girl of ten who came in contact with the wire while walking along the sidewalk. In this case the court declared that it was a matter of no consequence who was in fact the owner of the uninsulated and broken wire, saying that it was enough that it hung from defendant's poles under such conditions as to make it the recipient of the dangerous electric current from their wires and this condition, a position the defendants knew or by the exercise of ordinary care could have known and should have anticipated injury from. Here we have a case where the appellant (defendant) negligently permitted an uninsulated wire to hang from their poles within a foot or two of the public street; they negligently permitted the wire above it, which was charged with electricity, to become abraded as to its insulation, and negligently suffered these two wires to become and remain connected with a smaller wire . . . and both of these negligent acts concurred appellant's injuries.

To the same effect is Ahern vs. Oregon Telp. etc., Co., 24 Ore. 276, 33 Pac. Rep. 403, 22 L. R. A. 635, where a telephone company was held liable where it left a telephone wire hanging upon an electric light pole and where the employees of the electric light company had removed it and hung it upon a telephone pole so that the end of it was near the ground, the court went upon the theory that the telephone company was bound to look after its wires and see that they did not come in contact with an electrical conductor, the telephone company raised the question that the electric current was the approximate cause of the injury but the court declared that the negligence of the company rendered it liable.

Negligence may be presumed from the fact that one is injured by contact with a wire near the surface of the street, while he is lawfully passing along the street, and the law therefore raises a prima facia case from such injury forcing the owner of the wire to show that he was not negligent.

Snyder vs. Wheeling Elect. Co., 43 W. Va. 661, 28 S. E. 733, 39 L. R. A. 499.

And the owner of wires is bound to insulate them at points where a deadly current is used on them and people are liable to come in contact with it.

Overall vs. Louisville Elec. Light Co. (Ky.), 47 S. W. Rep. 442.

And the burden is on the defendant to show that it was not at fault because its wires were down in the street in such manner as to cause injury to pedestrians or persons traveling along the street with carriages, thus it was held as in the West Virginia case cited above where defendant was using an alley for its poles and wires, that one of its wires was down in the alley and that complainant's husband by walking along the alley struck his foot against one of the wires and was instantly killed.

Gannon vs. La Clede Elec. Light Co., 145 Mo. 502, 46 S. W. Rep. 968.

Right to Prevent City from Going Into Electric Business

Suit was instituted by J. P. Crouch and J. P. Burrus to enjoin the city of McKinney and its officers to restrain the said city from furnishing electric light to private citizens to be used in their private and business houses. It was alleged that the furnishing of said light to individuals would decrease the efficiency and effectiveness of the street lights already established and prevent the establishment of other street lights needed by the city; also, that it was in contravention of the Constitution of the State and the charter under which said city is operating; also, that it was diverting the revenues of the water plant to the operation of the electric plant, thereby using money procured by taxation for a purpose not authorized, when said revenues should be applied to the betterment of said water system; also, that the city is furnishing said lights to individuals at less than the cost of production, and to maintain the said incandescent system will necessitate large expenditure of money that can be derived only from taxation, which will not be used for public purposes, but for private gain alone. A temporary injunction was granted, and the defendants answered and filed a

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motion to dissolve. The McKinney Electric Light & Motor Power Company filed a plea of intervention, to which defendants filed an answer.

The court said the city of McKinney is operated under the general laws of the State incorporating cities and towns. Article 421, Rev. St. 1895 reads: "To provide for lighting the streets and erecting lamp posts therein, and regulating thereof, and from time to time create, alter or extend lamp districts, to exclusively regulate, direct and control the laying and repairing of the gas pipes and gas fixtures in the streets, alleys, sidewalks, and elsewhere." The city established an electric light plant in connection with its water plant and installed 31 arc lights in different parts of the city. It granted to certain corporations a franchise to install an electric light plant to furnish the citizens lights for their private and business houses. This franchise is now held by intervener, the McKinney Electric Light & Motor Power Company. It is conceded by appellants that the city had the power to install the electric light plant for the purpose of lighting the streets, but that its power ceased there, and that it was not the power to furnish electric power to individuals for lighting private and business houses, until all portions of the city are furnished street lights. There are some portions of the city that are not supplied with street lights, but this condition exists for the want of funds to install them. The people of the city voted the issuance of bonds for installing the electric light plant. The proceeds of the sale of said bonds were exhausted in installing said plant and the 31 arc street lights, and no funds remain for the extension of the street lights. The capacity of the electric plant is much greater than necessary for the lighting of the streets, and the excess or surplus is used by the city in supplying lights to individuals for their private use. When the city has a surplus of power, after discharging its duty to the public, there seems to be no question of its authority to sell the excess to private citizens. But it is contended that as long as portions of the city remained unlighted there could be no excess of electricity that could be disposed of by the city. This contention we do not think tenable. The government of the city has been intrusted to a mayor and board of aldermen, and, so long as the affairs of the city are conducted in a reasonable manner, their acts will not be interfered with. No fraud is alleged on the part of council in conducting the city government, and, "unless the council is transcending its powers, or some clear right has been withheld, or wrong perpetrated or threatened," the parties are not entitled to invoke the power of the court. All the proceeds derived from the sale of electric light bonds had been consumed in the installation of the plant and street lights. The council had used their discretion in placing the lights for the streets, and it was not practicable to extend them to other parts of the city. Under these conditions, rather than to have let the surplus power of the plant remain idle, it was better to sell such surplus of the electricity that was produced for private use.

The court charged the jury that the city did not primarily have power to furnish lights for private use, but, if the city had more power than was sufficient for the present condition and needs of the city, to find for said city. There being a surplus of power, the council had the right to expend current funds to put that power in use, and the expending of such funds in supplying electricity sold to its citizens for private use was not in derogation of the Constitution relative to taxation.

That intervener had a franchise to furnish the inhabitants with lights did not prevent the city from exercising the right to do so. The franchise of intervener was not exclusive, and had such a right been granted by the city it would have been void, as the power to grant such a franchise did not exist in the city. The franchise granted to the intervener did not prohibit the city from granting a similar right to some one else, nor of using it itself.

Crouch vs. City of McKinney (Tex.) S. W. Rep. 518.

Mercury Arc Rectifier Automobile Garage Outfit

By R. E. Russel.

In most electric automobile garages having a capacity for charging two or more batteries at one time, the charging is done directly from either direct current feeders, or through an A.C.D.C. motor-generator set, from alternating current feeders. The general connections are similar to those shown in Fig. 1, either with or without the motor-generator. There is a small number of garages using single circuit rectifier outfits, one for each battery to be charged, but while this method is very satisfactory

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and highly efficient, the cost of the original installation is rather more than most garages care to invest for this purpose.

	Circuit. No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	T'ls.
No. Cells.....	44	40	30	24	16	12	166
Volts Av.....	101	92	69	55	37	28	
Amps. Av.....	20	20	20	20	20	20	120
Watts Used...	2020	1840	1380	1100	740	560	7640
" Lost....	180	360	820	1100	1460	1640	5560
" Total...	2200	2200	2200	2200	2200	2200	13200
% Eff.	92	84	63	50	34	25	58

FIG. 1. DIAGRAM OF CONNECTIONS AND TABLE FOR CHARGING GROUP OF BATTERIES FROM MOTOR GENERATOR.

Referring again to Fig. 1, let us assume that six batteries are to be charged from the 110 volt busses, and that the number of cells in the various batteries is as follows: No. 1, 44; No. 2, 40; No. 3, 30; No. 4, 24; No. 5, 16; No. 6, 12. The tabulation in Fig. 1 shows the actual watts delivered to the battery, the watts loss in the rheostats and the efficiency of each circuit, neglecting the loss in the motor-generator set. It will be seen from the last column that the efficiency of the complete system, exclusive of the motor-generator set, will be about 58 per cent.; with a motor-generator set having an approximate efficiency of 75 per cent., the efficiency of the system will average about 44 per cent.

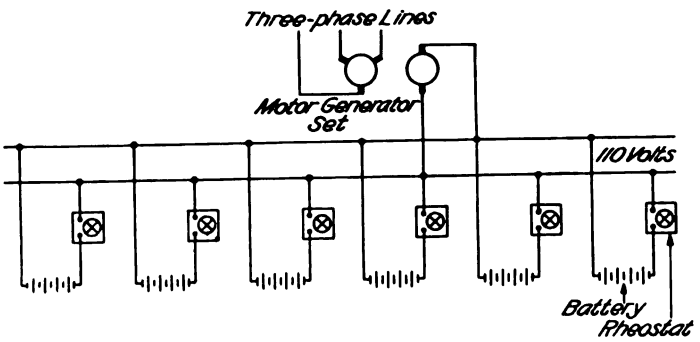

FIG. 1.

The General Electric Company has recently designed and built a new type of charging outfit for use on alternating current circuits which is known as the Catalog No. 46929, Mercury Arc Rectifier Automobile Garage Outfit. This outfit consists of a two-panel dull black slate switchboard with necessary compensating and regulating reactances, equalizing rheostats, rectifier tubes, and switches, all mounted with a view to obtaining the most compact and convenient equipment possible. The left hand panel of the switchboard is very similar to the standard rectifier outfit which has become familiar, and so it need not be described in detail. An additional feature on this panel is a triple throw transfer switch, by which the various A.C. voltages required in the operation of the outfit may be applied to the tube. The right hand, or charging circuit panel, is equipped with six triple pole double throw switches, and two 60 ampere ammeters; and also a six-point voltmeter switch for reading the voltages of the various batteries being charged.

The scheme of connections of the charging circuits is outlined in Fig. 2. The rectifier, when charging a group of batteries similar to that shown in Fig. 1, would supply the busses with an average of about 193 volts D. C. It will be noted from Fig. 2 that the six batteries are arranged in two circuits of three batteries each, the batteries being so divided beween the two circuits as to make as nearly as possible an equal number of cells in each. The table just below the diagram gives the corresponding losses and efficiencies when charging with these connections. It will be noted from this table that the average efficiency in the charging circuits alone, neglecting the losses in the rectifier and the very small losses in wiring, etc., is 99 per cent. As the efficiency of the rectifier when delivering 193 volts D. C. is about 84 per cent., the total combined efficiency of the complete charging equipment would be about 82.5 per cent.

Referring to the table in Fig. 1, it will be seen that the total watts used in the charging circuits is 13200. At 75 per cent. efficiency this would mean an input to the motor-generator set of about 17.6 kilowatts. As only 7,720 watts are required in the charging circuits from the rectifier, the total kilowatt input at 84 per cent. efficiency would be 9.2. It will be seen from this that the saving in power is considerable when using the rectifier. Of course, a part of this saving in the cost of power would have to be used for buying renewal tubes for the rectifier, but even considering this additional expense, the saving in power should figure out at least 20 or 25 per cent.

	Circuit. No. 1.	No. 2.	Totals.
No. Cells	84	82	166
Volts Avg.	193	189	
Amps. Avg.	20	20	40
Watts Used.....	3860	3780	7640
" Lost.....	0	80	80
" Total.....	3860	3860	7720
% Eff.	100	98	99

FIG. 2.—DIAGRAM OF CONNECTIONS AND TABLE FOR CHARGING CIRCUITS FOR AUTOMOBILE GARAGE OUTFIT.

While some garage managers might consider the combination of cells as charged under the above conditions an extremely unfavorable case, it should be borne in mind that batteries of the various numbers

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of cells mentioned are furnished by representative electric vehicle manufacturers for use in their "electrics." Nor is it possible for a charging garage to control the conditions most favorable to its charging plant; for example, garages are frequently called upon to charge a single battery of a large number

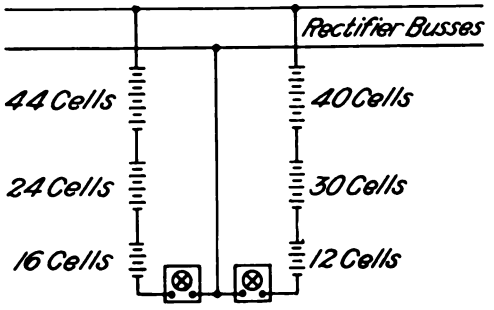

FIG. 2.

of cells, such as a 40 cell battery; and a large number of batteries with a smaller number of cells, say, five 24 cell batteries. When charging such a group of batteries from a 110 volt D. C. circuit, the efficiency would be about 44 per cent. When it is necessary to include a motor-generator set the efficiency would be approximately the same, while with the rectifier the efficiency would be as high as 75 per cent.

The tabulation of efficiencies, when charging various sizes of batteries, is given below. For the sake of comparison, the charging rate on all batteries is taken as 20 amperes and the average volts per cell as 2.3. While some batteries are designed for a heavier charging rate than 20 amperes, the average battery can be efficiently and economically charged at this rate, although the time of charging may be somewhat longer.

Fig. 3 shows the connections of the whole Rectifier Garage Outfit. It will be noted from this diagram that when a battery is connected to the terminals of each of the triple pole switches marked + and —, and the switches thrown in the lower clip, the batteries are connected in two series groups similar to Fig. 2. If a large number of 12 cell batteries are to be charged at one time, the two groups may be thrown in series by simply reversing the position of a double pole double throw switch on the left hand panel. However, for practically all garage charging the circuits will be connected in series multiple.

In each of the two charging circuits a standard battery charging rheostat is connected. This rheostat is for equalizing the load between the two circuits. In order to use as little of the resistance as possible the number of cells of battery in the two circuits should be arranged to be equal, if possible, and if not equal, as nearly so as practical. When it is desired to cut out a battery for any reason the switch to which the battery is connected should be opened, a sufficient amount of the charging rheostat cut in and the switch thrown into the upper clip. This cuts out the battery, but the series circuit is not broken and the charging of the remaining batteries will be resumed.

The switches have been arranged with the idea of making them as "fool proof" as possible. It is impossible, with the arrangement of connections, to short circuit the rectifier tube by throwing all the switches in the upper clip; one battery at least must be connected in the circuit before current will flow through the tube.

The Rectifier Garage Outfit should be supplied with alternating current of 220, 330, and 440 volts. By applying these various voltages a wide variation of direct current voltage can be obtained and from a single 14-cell battery to six 30-cell batteries may be charged at one time.

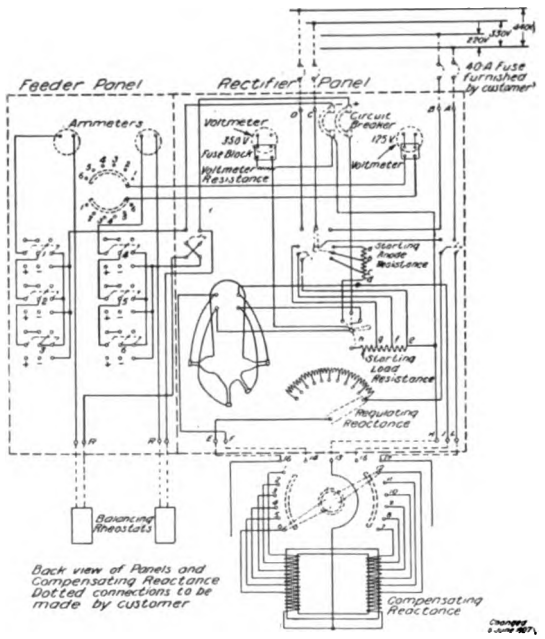

FIG. 3.—COMPLETE DIAGRAM OF CONNECTIONS OF MERCURY ARC RECTIFIER AUTOMOBILE GARAGE OUTFIT.

A large number of these outfits have already been sold and are apparently giving excellent satisfaction.

Battery.		Efficiencies.		
Number Batteries.	Cells per Battery.	With D. C. Supply 110 v.	With M. G. Set.	With Rectifier Garage Outfit.
5	24	44%	44%	75%
1	40			
4	30	58%	59%	84%
2	24			
4	40	64%	50%	84%
2	12			
6	24	50%	54%	84%

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The Central Station

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS

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Advertisements, Changes in Advertisements, and Reading Matter intended for the next month's issue should reach this office not later than the twenty-fifth of this month.

No commissions are allowed on advertising contracts or subscriptions.

Entered at the New York Post Office as Second Class Mail Matter.

Two Suggestions to "The Man Who Signs the Checks"

The scarcity of money seems to be the "root of all evil" just now and ways and means of bringing out the foolishly hoared millions are being discussed. In many cases the echoes of the talk are about the only results and little of account is actually accomplished.

The way to resume—is to resume—to do a thing something must be done and the ability of the central station manager and the manufacturer to "get right down to brass tacks" and *do something* is in the present emergency to be relied upon.

Through the medium of "accounts payable" and "accounts receivable" much can be done by the public spirited men of the country to restore business conditions to their normal and prosperous state.

It must be generally admitted as a fact that a corporation or an individual cannot pay out money unless it has a large cash surplus or can collect from its debtors the moneys that are due. Collections are now slower than normal. It therefore logically follows that to resume payments of accounts due, accounts receivable must be started coming in. If that can be done it will serve as a helpful factor at the present time.

On the first of the month millions of statements will be sent throughout the length and breadth of this great and glorious America of which we are so proud and in whose fundamental strength we have such confidence—though all of us are not showing it just now. Many of these statements will carry antagonistic rubber stamp paragraphs reading "Please Remit," "Long Overdue" and other far from effective requests to pay up.

If instead every monthly statement that goes out were to bear the following patriotic appeal in big display type and red ink, the Americanism in the breast of the "man who signs the checks" would prompt him to join in the movement of that endless chain of payments justly due and the consequent good morning mails would result in a batch of checks of equal amount going out in the afternoon from establishments generally.

This or something similar should be on every statement mailed to a debtor and on all outgoing invoices as well.

TO "THE MAN WHO SIGNS THE CHECKS"

The spirit of patriotic financial co-operation should govern us all at this time—and the most practical method is for us to pay each other the bills we owe.

We are doing what we can in that direction. Will you help us? We'll promise to start your remittance on its way immediately upon receipt, to do its full share in restoring confidence and prosperity for us all.

"THE WAY TO RESUME IS—TO RESUME."

Here is the second suggestion: The man who has money is a power—to-day as never before. When he pays a bill let him now do it as effectively for the general good as possible and instead of enclosing the check in a curt note, reading "Enclosed find check"

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—or possibly with no note at all—he should see that with each check is sent a form letter or a printed slip reading somewhat as follows:

In sending you the enclosed check for our account we do so in the hope that you will immediately continue it on its way to do its full share in restoring confidence and prosperity for us all.

The spirit of patriotic co-operation should govern us all at this time—and the most practical method is for us to pay each other the bills we owe.

American central station managers and manufacturers have never been found wanting in a patriotic emergency. Put your shoulder to the wheel with the rest of us—NOW.

Yours for Continued Prosperity,

(Signature.)

The suggestions here made may perhaps be elaborated upon, but if generally adopted they will improve that "morning mail"—that index of improving conditions that every "man who signs the checks" is just now watching with even more careful scrutiny than he scans the weekly bank statement.

We urge you all—manufacturers and central stations—to act upon this suggestion. First of the month statements and all outgoing checks can thereby be made the advance agents of a returned prosperity.

Central Station Development

For many years it has been the custom of half-baked experts to express opinions on the subject of power supply in connection with central stations and isolated plants. The point at issue has generally been that pertaining to the cost of electricity from each of these sources respectively. Of late years the issue has become less interesting than heretofore, for reasons which have rapidly become obvious to even the lay mind. In other words, the tendency to air technical questions of public importance in the daily press has been the means of bringing to the acquaintance of business men problems which were originally thought to be beyond his ken. The half-baked expert, therefore, has no such chance to-day as he had in the past to air his opinions, or to pronounce a verdict in favor of an isolated plant or central station service as much as was his prerogative in the past.

The reasons do not lie so deep down as might be supposed. In fact, it is only necessary to take a casual survey of the situation with respect to central station development, and it will be readily seen that service from this source of light and power has become so systematized, so reliable, so cheap and incidentally so convenient, that it would require a much more powerful argument than was ever offered in the past, to induce a merchant, large hotel keeper, theater manager or his like to undertake an enterprise involving a large investment and dangers of failure in accomplishing the object sought. There are always two standpoints to be considered with respect to any vital change in a long-established method of practiced economy. The first is necessarily the inducement which cheapness holds out and the second that which appears in the guise of convenience. In the former undeveloped stage of electric lighting interests, when the question was seriously considered as to whether electric lighting in a city is best done by a private plant or a central station, it was indeed difficult to find a solution to this problem for the simple reason that both time and experience were necessary to teach the lesson to be learned. These two influences have clearly pointed out the way, and as far as saving in bills and convenience and diminished risk are concerned, central station service holds its own, not only in a general way, but in many specific instances where it might seem as though a private plant would be the best to install.

Central station development, therefore, does not relate entirely to the mere technical development of the central station as a more or less complex organization which produces electricity for public use, but it refers equally to the influence on the public mind which a certain high stage of development has been the means of causing. In every instance where growth assumes a certain high plane, influences can be legitimately attributed to it, which could not otherwise become evident, except in such a case. And so a certain confidence has been slowly developed and widely established, due entirely to the technical perfection which may be found in the leading central stations of the United States. This perfection relative, of course, in the light of modern progress, is found in the shape of boilers, engines, turbines, generators, switchboards, the accessories of central station service and the system by means of which the operation of all machinery is correlated to a single purpose. A correspondence is thus established between the internal operation of the station and the external needs with which it must al-

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ways be in harmony. When this is true, the demand for current is sufficiently great and regular enough to be the means of yielding a reasonable profit on the investment made. The purpose, therefore, which makes itself evident in the end, to develop a money-making machine supplying certain public needs, gaining its confidence by being reliable in this respect on all occasions, yields distinct financial advantages only in proportion to the degree to which the station has been developed. On this basis, at least what is ordinarily termed central station development has advantages which no manager can afford to disregard. Technical excellence, engineering ability, financial conscientiousness and a population alive to the value of innovations are the means by which central station development is accomplished. On these grounds, it is seen how impossible competition would be where private plants are concerned or other stations poorly run are in the field.

Some Features Concerning Gas Producer Plants

Many questions have arisen since central stations have taken the lead among the light and power industries of the country as to the best means of obtaining the energy of coal. The ordinary practice is that of consuming the coal in a closed place and permitting its heat to pass into the base of a boiler through which steam is generated. The fact that a great deal of energy is wasted in this manner has led to the adoption of many expedients to get more energy from the coal with less waste. One of the expedients adopted is that of distilling the coal, or, in other words, of shoveling it into a gas producer first and then using its energy in that form to heat the boiler. A steam plant thus becomes dual in nature. On the one hand, we find the gas plant and on the other hand the steam apparatus with its generators, etc., attached.

The reason for experiments of this kind being tried is that there is an absolute gain in the use of gas distilled from coal over the old method of burning the coal under the boiler and abstracting as much heat as it would be possible to obtain. Some light on the subject might be of interest to those contemplating any change in the system at present employed. It is evident that one advantage which a gas producer system involves is its ability to extract the energy from grades of coal that could not be conveniently burned under a boiler. For this reason, there is a possibility that many more gas producer plants than those at present in vogue may come into service in districts where inferior grades of fuel may be found in abundance. The same, of course, can be said of the use of oil which, turned into gas and stored, would certainly prove a most convenient means of heating a boiler. Where the choice, however, lies between the direct use of oil under the boiler, provided its grade is sufficiently high to permit this, there is no likelihood that it would be used in a wasteful manner which would be implied by its transformation into gas in a producer system. In other words, where fuel is good, it might prove to some too expensive or a source of too much inconvenience to make a change of so radical a character as the introduction of gas for heating the boiler instead of coal direct. But, where the fuel and the conditions are ripe for such a change, it seems as though it could be made without unusual risk or expense and prove to be a decided advantage.

At a meeting which took place in Cleveland of the Ohio Society of Mechanical, Electrical and Steam Engineers, Professor Fernald spoke as follows of the conditions under which the producer plants could be installed: "The installation of a gas producer plant," he said, "will run from fifteen to thirty per cent. higher than steam up to 1,000 horse-power, and about ten per cent. higher from 1,000 horse-power to 5,000 horse-power. In larger plants, the cost will be about the same, as has been shown with a plant at St. Louis. The gain in the cost of operation will make up for the additional initial cost in from 1½ to 2½ years," he said, "depending upon the size of the plant. One ton of coal will produce as much energy in a gas producer plant as two and one-half tons in a condensing steam plant."

Some of the opinions advanced by the writer which precede the quotation marks were more or less reiterated by him in advancing his opinion on districts supplied with inferior fuel. He claimed that a plant can be operated with refuse coal which he said is piled up by the hundreds of tons in the mining districts at a negligible cost. He furthermore said that tests have been made along this line, and the manufacturers of gas producer gas plants are now getting ready to take them to the mines as a further test of what they will do. His remarks in connection with central stations were of unusual interest. His firm belief that the use of gas producer gas engines in central stations will greatly reduce the cost of producing energy, is only to have been expected from a man who has kept in touch with the development of central station practice and the means of improving it that have been afforded by contemporaneous inventions. It seems to be a matter of vital importance to the managers of central

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stations to keep in touch as well with the trend of events as far as this method of producing cheaper energy is concerned. The entire central station problem and its adequate solution depend upon the methods employed not only to provide facilities to the public for light and power, but to hold in check, or even to diminish the cost of production or electrical energy. In every growing city real estate keeps bounding up, taxes increase, the cost of transportation and freight rises, and wages as well undergo advancement. It is quite evident, therefore, that the tendency to increased cost of production for current on the one hand cannot be met by increased charges for current on the other hand. The public will not stand for the second thing, even though they may be well aware, such of them for instance, as are business men competent to judge, of the increased cost of production.

There are certain industrial conditions prevailing at times which make it difficult to obtain financial results simply due to their existence. These conditions are sometimes the result of public opinion, and at other times more or less the result of hasty conclusions most irrational in basis. The contention on the part of the public that they pay enough does not always mean that the companies are in a position, if representing a central station, to make as much as might be claimed. It is necessary, therefore, even though it means a radical change in the heating methods employed, to discover the exact truth regarding the utility of gas producer plants in central station service and if, as evidence seems to corroborate, there is a distinct saving in cost of fuel due to improved methods of obtaining its energy. it seems to be only a matter of course to introduce a system of this character.

The Color of Light Sources

Articles occasionally occur in publications, as well as correspondence from various subscribers, touching upon the color of illuminants or light sources. This is a subject of great importance to the central station, because of the need it involves for a supply of practical advice. The light source with which we are fortunately most familiar with is ordinary daylight, and it is the custom to compare other light sources with this as a standard. The incandescent lamp, in contrast with it, is considered the producer of a yellowish light, while the light from a Cooper Hewitt tube is greenish in hue. The arc lamp of the type known as enclosed, produces a white light, but other varieties bearing the title of flaming arc produce reddish or yellowish light. The most popular of all light sources at present in use is the incandescent lamp, and the reasons for its popularity are not hard to divine. It is a unit of light which can be conveniently handled, and by means of modern improvements, regulated to any degree of candle-power desired. But instances do arise where customers are apt to inquire as to the cause of the yellowish glare, as they describe it, coming from the lamp. Complaints against any form of illumination are not rare, in fact they seem to be the regular thing, entirely due, we think, to the diversity of tastes which exists.

As a general rule, a clear light is preferred in the majority of cases. Not one tinged with too much yellow, or one too white; but a light that is eminently agreeable to the eyes, of a faint yellow tinge. Experience has shown that a necessity has arisen for a proper admixture of light waves. For instance, the aforesaid mercury vapor lamp lacks red rays and in consequence shows this deficiency by a greenish glow. The incandescent lamp shows a predominance of red rays, which give a yellowish cast to its light. While the arc lamp, if not of a violet tinge, as far as its light is concerned, represents the best admixture of rays that has thus far been produced, yielding a very white and brilliant form of illumination.

An interesting experiment which may be tried for the purpose of establishing these facts, is to develop a hunger in the eye for red rays. This is accomplished by leveling the eyes at a Cooper Hewitt tube and then turning them on an incandescent lamp. The effect of this will be to make the lamp appear red instead of yellow, due to the fact that the eye has been stimulated by all but red rays in the mercury vapor lamp and is therefore highly stimulated by the red rays in the incandescent lamp. It is simply a case of changing the form of stimulation, and represents a method of demonstration which leaves little or no argument in its train. And this experiment also illustrates the need for illuminants that supply light which is in every way refreshing to the eyes. Some of this effect is noticeable in staring at a rather old Welsbach gas mantle, a light source which threatened, at one time, to become a permanent form of illuminant. The moral of all this is that the æsthetic sense of the public enables it to determine what is best, without aid or suggestion, and for this reason, when it makes its choice, by rendering any particular electric light source, popular, experts may be sure that it will be hard to change it, until not an equivalent, but a superior light source is introduced.

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The Illumination of a Room

The lighting of a room does not seem to offer any difficulties of an insurmountable nature, yet upon investigation it will be found that the correct way to light a room is more or less unknown. This bald statement can be borne out by facts obtained from observations of a specific, as well as a general nature. For instance, the amount of light required in a room is naturally of primary importance, yet, unless the subject is discussed by an expert in lighting, there is little doubt as to whether there will be either too much or too little light introduced. But aside from the question of light and the quantity which is to be used, comes the second question of the character of the room, or at least the material with which its walls are covered. Some interesting data may be presented in connection with this subject, which relates to the amount of light absorbed by papers of different colors in a room. It will then be seen how difficult it is to assume that a given amount of light will be sufficient, if arbitrarily considered, to provide illumination sufficient for ordinary purposes.

It is found that red and dark green wall paper absorb over eighty per cent. of the light which falls upon them. In connection with this it may be said that only twelve per cent. of the light falling upon paper of this hue is cast off. This being the case, it is easy to realize that the optical sense would receive an impression, even with a candle-power ordinarily sufficient, of inadequate lighting. White wall paper absorbs only eighteen per cent. of the light falling upon it, and returns eighty-two per cent. to the room. Blue wall paper absorbs seventy-five per cent. of the light falling upon it and returns only twenty-five per cent. to the room. Other values could be given for colors ordinarily used in decorating a room, and it would be surprising to discover how little light is thrown back from any paper except pink or white. Such being the case, it is quite obvious that correct illumination is only possible under conditions which appear as follows: First, an assurance that the amount of candle-power employed bears some relationship to the floor area of the room, and secondly, that the general tint is such that the major part of the light, when absorbed, does not materially cut down the light impression it should produce.

A certain number of square feet of floor area means an allowance of a certain candle-power if a room is to be lit with some degree of uniformity. Some experts place the values at from three to six square feet per candle-power. Accepting the smaller figure, a sixteen candle-power lamp would be able to light about forty-eight square feet of floor surface. But of course this is largely a matter of taste, and as such cannot be given in absolute figures. If the tone of paper, however, is such that a very heavy percentage of light is absorbed, it is evidently advisable to increase the candle-power per unit area of floor space to a point where the effects of gloom will be dissipated. In other words, the individual taste must be consulted before a given number of sixteen candle-power lights are installed and a knowledge possessed, at the same time, of the color scheme.

Drawing rooms are a source of the greatest trouble to professional decorators, for the reason that they are not always able to decide upon the proper number of lights, even if they could. It frequently happens that the customer does not want as much light as may be absolutely needed to cause proper illumination and in consequence, in spite of the art employed, the effects are not sufficiently good to be acceptable. Where decorative lighting is done, it seems as though the light expert or expert in illumination is an absolute necessity. His training is both technical and æsthetic and such a man's services would be of the utmost value to customers, as well as decorators, were he called in, in the proper capacity, to give his opinion.

Joint Construction Pole Lines

By H. B. Gear.

The rapid extension of telephone and electric light distributing systems in recent years has caused the erection of pole lines on many of the principal thoroughfares of our American cities. In many cases all the available space for such lines has been occupied and this has resulted in a badly tangled condition of poles, wires and service drops. The situation is further much aggravated in some cities by the presence of two telephone systems, thus making three claimants for space in the public streets and alleys.

In the average American city there are, therefore, two or more pole lines in most of the principal streets and alleys with service drops from each pass-

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ing over, through and under the other in a very unsightly and dangerous manner.

These conditions are especially bad in alley construction where the pole lines are necessarily close together and the opportunity for proper clearance is very limited.

The increasing danger of such conditions as these has led the lighting and telephone companies in some cities to enter into arrangements for the joint use of pole lines. This policy has been further encouraged by municipal authorities who are desirous of keeping the number of poles on public thoroughfares down to a minimum, in response to an increasing public sentiment favoring the removal of poles from streets.

Joint arrangements have been in effect in the city of Chicago between the lighting and other companies for the past eight or nine years with the result that a comparatively small part of the distributing systems of the lighting and telephone companies occupy separate pole lines on the same street or alley at the present time. The lighting wires are carried on the top of the pole with a clearance of five feet between the lower cross arm of the lighting company and the upper cross arm of the telephone company. The lighting company's transformer is allowed to encroach on the clearance space, provided that at least 3½ feet is maintained between the bottom of the transformer and the top telephone wire. Ground wires on secondary lines and lightning arresters are covered by a half round wood moulding for the protection of linemen as well as to prevent the possibility of any stray current being communicated from the ground wire to the telephone system.

The telephone company limits its open wire equipment to two cross arms and a service buck arm in outlying districts and to one cross arm in the more congested districts. Cables are used for the transmission up to within a block or two of the location of the telephones served. This avoids the necessity of extra cross arms for through lines and greatly reduces the possibility of crosses with lighting services or high tension wires. The lighting services being taken off above, the telephone wires cannot pass through or under a telephone line and are therefore not likely to become crossed with the telephone wires. Being the stronger, they are not so likely to break and fall across the telephone lines as would the telephone lines be to break and fall across the lighting lines were they run above. A clearance of two feet is maintained on the sides of buildings between lighting and telephone services. Where underground lighting cables are brought up a pole the iron pipe is extended to the top of the clearance space, thus safeguarding the telephone linemen and minimizing the danger of a cross between the lighting and telephone wires.

The major portion of the distributing systems of the lighting and telephone companies in Chicago is carried in alleys owing to the existence of a very general alley system, which makes it unnecessary to utilize the streets except for three through lines. The through lines are in many cases carried under ground on the streets with lateral connections at alley intersections for the distributing lines.

1. There is some advantage to both companies in joint pole arrangements from the standpoint of investment. The equipment of the two companies may be carried on one 35 or 40 foot pole instead of on two 30 or 35 foot poles in case the lines were not joint. This saving amounts to approximately 15 or 20 per cent. of the investment in overhead lines in cases where new lines are being built. But in cases where either company desires to extend its lines along routes already occupied by the other company, it is usually necessary for the company which desires to make the extension to do more or less reconstruction work. Where poles must be replaced in order to secure sufficient height for the wires of both companies, the expense incurred by the original company in transforming its equipment from the old to the new poles, must be borne by the new company, and the cost of the line usually amounts to about what it would have been had the new company constructed a new line on the other side of the thoroughfare. There is little saving in investment to either company, in such cases. The telephone system usually precedes the lighting system in growing sections and unless the lighting company can forecast its requirements in such a way as to be able to take ownership in poles before it needs them, it must stand the expense of providing space on the telephone poles by lowering the telephone equipment or replacing the poles.

The operating advantages are, however, considered such by the Chicago companies that in all such cases the old line is reconstructed in preference to erecting a second line on the opposite side of the thoroughfare.

2. The use of joint pole lines has, however, some objections which may not be overlooked. The service of each company is likely to be interfered with by the employees of the other company, who may be engaged in construction or repair work in which they may carelessly or ignorantly cause injury to the equipment of the other company. It is therefore

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essential that the relation between the employees of the companies interested should be friendly and a spirit of forbearance must exist at all times.

The details of the business arrangement covering the erection of new lines and rearrangement of old lines are very numerous and at times perplexing. When once established, however, the various employees interested may be given a policy to follow which can be carried out without undue friction.

The arrangement in effect in Chicago may be outlined briefly as follows:

Each company, when it proposes to make any extension of its lines, notifies the other company by letter of its intention, giving a description of the number, size and location of poles, which it intends to erect. Several copies of these letters are passed between the companies so that each situation may be looked over by the foreman or inspector, who makes a recommendation as to whether or not he considers it advisable for his company to take an interest in the poles which are to be set. If the foreman of the other company desires larger poles he may ask for the same and they will be set as requested by the other company. Payment is then made on the basis of the number of gain spaces reserved for the use of each company.

If the other company does not feel that it will require space on the poles within a reasonable time it reserves the privilege of refusing to take an interest in the poles which are to be erected.

In case one company wishes to extend its lines where the other company already has a line it will ask for space on the existing poles if they are high enough and will attach its equipment after agreeing to purchase from the other company an interest in the poles concerned. In case of the lighting company, however, it must stand the expense of the other company lowering its equipment in order to provide space for the lighting wires at the top of the pole. In case the poles in the existing line are not tall enough for the equipment of both companies, the incoming company replaces the existing poles at its own expense, taking the old poles as salvage and paying the other company the expense incurred by it in transferring its equipment from the old to the new poles. The new poles are then jointly owned by the two companies.

The expense of maintenance of joint poles is shared by the two companies in proportion to their interest in the pole.

In cases involving reconstruction work and in cases where either company proposes to do new work where separate parallel lines exist, representatives of each company meet on the ground and agree upon a suitable arrangement for the consolidation of the existing lines into one joint line. In such cases each company stands its proportion of the expense of the new work and transfers its equipment from the old to the new poles at its own expense.

In general, the lighting company is apt to bear the greater portion of the expense owing to the fact that it must pay for the lowering of the other company's equipment; also because the lighting lines are usually preceded by telephone lines so far that the lighting company cannot forecast its requirements with sufficient accuracy to derive the benefit of taking an interest in the poles when they are originally set.

The safety to the lives of employees and the public, as well as the diminished fire risk are well established by the fact that hardly a single serious case of trouble has occurred in seven years of operation of joint lines. This record has been made on lighting and telephone systems which have been rapidly extended until there are at the present time about 25,000 poles jointly occupied by the wires of the Chicago lighting company and the Bell Telephone Company.

Joint arrangements are also in effect on about 2,500 poles with the city telegraph and street railway companies. In addition to this the city of Chicago has the privilege of attaching its wires for electric light, fire alarm and police telephone companies. It is therefore frequently necessary to provide space on the upper part of a joint pole for the lighting wires of the city and on the lower part for the fire alarm and police telephone systems. In general, all signaling systems are kept on the telephone company's portion of the pole and all lighting or traction systems on the lighting company's portion of the pole.

Cases of triple occupation in which the city is the third party are numerous, but triple occupation with other companies is not frequent.

The writer realizes that methods which can be applied in metropolitan work are always suitable for smaller cities on account of the limited resources of the companies involved which prevents the use of underground work to any great extent. In cities where the main runs cannot be carried underground separate routes on high poles should be established for these by each company and the distributing lines which it may be necessary to have strung along those routes may be carried well below the through lines.

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As far as possible the through lines of the telephone company should be carried in aerial cable, which, for a considerable number of lines, is practically a physical necessity in any event.

The presence of two sets of telephone distributing systems is at best a deplorable condition from either standpoint and joint construction of the three companies involved in such situations is not practical under existing conditions, though entirely feasible from a construction standpoint. Conditions can be somewhat improved by the encouragement of one of the telephone companies to operate jointly with the lighting company.—*Read before the Western Assn. of Electrical Inspectors.*

MONTHLY REVIEW OF THE TECHNICAL PRESS

Defective Lightning Conductors

Ninety-five per cent. of the cases of faulty lightning conductors that have come under our observation have been due to bad earth connections. The remaining 5 per cent. were traceable to (*a*) loose rag bolts near the apex of the conductor, causing the collapse of the latter, to (*b*) imperfect metallic joints about the finial rod, and to (*c*) oxidation. Not infrequently a large building is fitted with a solitary conductor, whilst vulnerable parts are left unprotected. Whether the number of conductors should be directly proportional to the magnitude of an edifice and what actually constitutes the danger zone of a lightning flash are questions that cannot be adequately treated under the heading of "*defective* lightning conductors" without unwarrantable digression—a mistake that will not be made. Exceptional combinations of circumstances call for special consideration, and hence it is desirable to have the opinion of someone whose theoretical knowledge has been supplemented by a wide experience. Within certain limits a defective conductor becomes dangerous, as discharges of atmospheric electricity can find a path to earth through some part of the building offering less electrical resistance.

Most of your readers would have supposed that all the difficulties before mentioned and hereafter considered must have been surmounted long ago, and that in regard to them nothing remains to be said. Seeing that standard works in the subject are obtainable, that lectures have been given and valuable papers read before various public and scientific institutes showing how to differentiate between good and bad conductors, it is certainly surprising that so many *preventable* faults continue to occur. Either the jerry contractor secures most of these jobs, or else the average client is reluctant at incurring the slight expense consequent upon a periodical test; possibly a combination of both misfortunes is the correct explanation. It would appear that the public are supremely indifferent concerning the efficiency of their conductors so long as the finials point vertically towards heaven. Instances could be recorded where lightning conductors have been neglected throughout a period of 15 years. Nowadays it is considered good practice to make an inspection and test at least once per year. The company with which the writer is identified makes it a rule that all conductors shall be tested every six months. A report is afterwards submitted detailing the resistance in ohms and the state of the weather during testing operations. A comparison

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can then be made with the previous record, an increase in the electrical resistance noted, and the probable development of a fault ascertained.

As a rule, the technical press gives encouragement to any writer having a story to tell, providing it is well told, is not too long, and is worth telling. Some time ago one of your contemporaries published an article upon a subject that need not be specified. The sentences were well balanced, and the composition all that could be desired. When, however, the author attempted to define a "good earth," he stated that the copper plate should be buried in *cinders!* Suspicion was at once aroused as to whether that author had ever been responsible for the maintenance of an installation of lighting conductors, or of telegraphs, or indeed of any electrical system where a low resistance to earth was a desideratum. If coke had been named in preference to cinders, comment would have been superfluous if the unconsumed pieces of arc lamp carbons had been recommended as being vastly superior to either, the advice would have been excellent, and no complaint could have then been urged against the article, which in other respects was commendable.

Reference has been made to jerry contractors. A gentleman of this class secured the contract for the protection of a large warehouse on the recommendation of his being a local man. Four main conductors of copper tape were specified, and the work was commenced in due course. His method of procedure was more interesting than convincing. Instead of completing one conductor at a time, all four were left in a partly finished state. Within 6 ft. of the ground the free end of each conductor was coiled up and wedged into a chase of the warehouse wall or other suitable aperture—there to remain pending the arrival of the copper plates and until a suitable subsoil had been decided upon. As this occurred in midsummer when thunderstorms were prevalent, the contractor received peremptory orders to complete the underground portion forthwith, or temporarily remove the aigrette rods. In adopting the course last named, he did so with no good grace, being annoyed that anyone should presume to suggest something relative to his business with which he was not already acquainted. "Why!" he expostulated, "I once fitted a conductor to a town hall, and bored holes all over the earth plate—a contract that gave every satisfaction." "What was the object of the perforations?" inquired a bystander, "Was it to allow the lightning a means of escape?" "Certainly!" he replied, with condescending frankness.

The number of faults caused through copper earth plates being laid in dry shallow ground is far in excess of what might reasonably be expected; whilst the quantity of oxidized conductors—terminating in putrid earthenware drains—is by no means small. Bad workmanship can never be condoned. Granted that it is not always an easy matter to find a "wet" earth, unless excavations are continued to an abnormal depth, the fact should not be lost sight of that difficulties are things to be overcome. More than one solution is, of course, possible, but on several occasions an attachment of the copper tape has been made with an adjacent water pipe, thereby dispensing with the customary ground plate. Under these conditions the resistance to earth will rarely exceed 0.25 ohm, and our experience justifies the opinion that electrolytic action need not be feared. Nevertheless, in certain quarters there is still an objection to waterpipe attachments, and in others the reliability of such connnections is thought doubtful. Was it not Descartes who wrote "a man can more easily burn down his own house than get rid of his prejudices?" Any apprehension ought surely to have been dispelled after the pronouncement of Lord Kelvin on the subject. In the discussion following Sir Oliver Lodge's paper before the Institution of Electrical Engineers, his Lordship stated that *"an ordinary house can be made exceedingly safe by connection with the water pipes."* "I would connect all pieces of metal to each other and to the earth if you can; but if you cannot (in the absence of water mains) connect each of them to an earth, then connect them to the lightning conductor, and give *it* a good earth." Inattention to an important detail may render even this excellent arrangement unsatisfactory. An electrical engineer who claims to have applied his system of protectors in all parts of the United Kingdom, once explained that he never made a practice of sweating the conductor to the underground pipe. All that he believed necessary was to wrap the metal tape two or three times round the water main, then bolt the loose end back to the conductor proper, finally smearing the whole with a coat of black varnish. Whether it is not the better plan to metalically unite the conductor and pipe by means of a lead pot or blow lamp may be left to the judgment of those of our readers sufficiently interested to consider the point raised. A standard specification for lightning conductors throughout the United States Navy has lately been issued, and one clause prescribes that every joint shall be "sweated with solder."

A ridiculous method of completing a conductor

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was discovered a few years ago whilst staying at the residence of a friend. The finial soared proudly above the chimney pots in orthodox fashion. The copper rope was carefully separated from the wall side by means of glass insulators resembling the ink wells of boyhood memory. An old cottage oven situate at pavement level served as a receptacle for the end of the conductor, and the oven door as a lid for inspectional purposes. As might be surmised, the oven was found dry and rusty, whilst the copper rope, coiled therein, was covered with verdigris. Inquiry elicited the news that the coachman was expected to fill the oven with water as, and when, required, but that pressure of business had led to the duty being overlooked. This antiquated oven was eventually "scrapped" and a copper plate, buried deep in damp soil, was substituted; a plentiful supply of coke improved matters so far as conductivity was concerned. The glass insulators referred to were replaced by suitably shaped hold-fasts and a first-class repair effected. This latter tribute to good workmanship is all the more willingly paid since the writer had no pecuniary interest in the affair whatever.

Thefts of copper plates on completion of a contract are happily rare though not imaginary occurrences. Should the offender escape immediate detection, a periodical "bridge" test will reveal unworthy tactics of this sort whether practiced by an unscrupulous employee or discreditable employer.

It will be generally conceded that in the class of faults to which attention has been directed there must have been a flagrant neglect of the principles governing the erection of lightning conductors; yet *on no occasion was the building damaged by lightning*. To infer from this admission that a building is as safe without a conductor as if one were provided would be distinctly wrong; and such a deduction could not be maintained without disregarding all that modern science has established on the subject.

Rather do the foregoing incidents tend to demonstrate the value of conductors, notwithstanding that forgetfulness and other causes had led to the development of certain objectionable features.

Lightning is an electric discharge, and as such it should act in accordance with known law. Thus, if a conductor fastened to a chimney stack were struck by lightning, the discharge would follow the metal path, and,, assuming further that the rod, tape or rope, whether of iron or copper, terminated abruptly in a filthy drain any disruptive effect would take place below ground instead of shattering the superstructure. Corroborative evidence may be recalled with advantage. In his lecture, delivered at the School of Military Engineering, Chatham (December 6th, 1906), Mr. Alfred Hands affirmed that electrically bad joints and a bad earth connection would not force the discharge to "go through the masonry. Bad joints would only cause injury to the conductor; and a 'bad' earth would probably result in a barrow load or so of soil being blown up. The concussion due to the explosive force that blew up the ground might possibly crack the masonry slightly on the surface, but this would be the worst that would happen."

Having dealt with that phase of our subject relating to buildings which escaped damage though fitted with faulty conductors, a concluding incident will be cited differing somewhat from those previously described, yet the cause was traced once more to a bad earth connection. Instructions were received to investigate a case of lightning conductor failure. As usual, there was considerable divergence of opinion respecting what had really happened, but the occupants of the premises asserted that simultaneous with a thunder crash, heavy flashes of lightning pervaded the building—fortunately leaving the structural parts intact—the lightning bolt finally plunging into the greensward beside the entrance door. After hearing this account, an exhaustive "bridge" test was made of the lightning conductor, which test gave unmistakable evidence of high and variable resistance. Examination showed the copper rope to be free from sharp bends, and a close inspection revealed no trace of "side flash" effects. The ground was next opened out where the lightning "bolt" was alleged to have plunged; and then the source of the complaint became manifest. A large *dry* joint was found in the conductor, which lay in a subsoil devoid of moisture. Every strand was badly oxidized, and the style of joint was crude and ineffective. Presumably the contractor had miscalculated the length needed, and finding that a joint could be made out of sight he completed the order in the least inconvenient way. A more charitable interpretation would be to assume that the conductor had been snapped asunder at some time during drainage excavations, and that a temporary re-connection had been made without notifications of the fact. Whichever view is the more cogent, it is safe to conclude that a complaint would never have been lodged, nor would any alarm have been experienced if the conductor had been continuous throughout its whole length.

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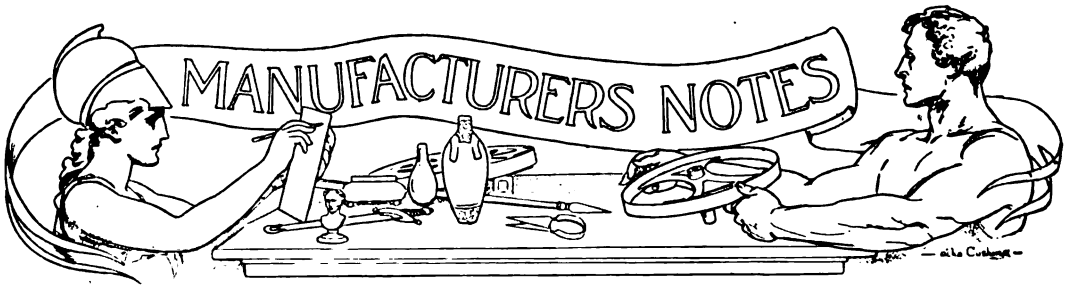
From the particulars furnished, support is lent to the theory that the lightning stroke was due to what is technically known as "impulsive rush," there being no time for the usual brush discharge to act. The thunder cloud nearest the building became suddenly electrified by a flash from higher clouds, each one discharging into the other in rapid succession until the conductor was struck. The peal of thunder coincident with the lightning (or nearly so) was brought about by the heating effects of the electrical discharge and the rapid rush of air along the track where rarefaction had taken place.

Encountering the oxidized joint below ground, the lightning became disruptive at that point, disturbing a portion of the greensward and raising the potential of surrounding objects to an enormous degree. The phenomenon observed among the stanchions inside the building was most likely a result of the surging effect of the current, the action of which has been proved analogous to the oscillatory discharge of a Leyden jar—that is to say, the electricity flows backwards and forwards in the circuit several times before the jar or condenser becomes finally discharged.

We have tried to emphasize the importance of a good "earth" and a periodical test. Too often the work of a predecessor in lightning conductor installations is denounced by a newcomer as "all wrong," while his own accomplishments in the same direction are unquestionably "all right." Such vague generalizations are out of place at the present stage of the art. Greater exactitude is wanted. Prof. Fleeming Jenkins was not far wrong in remarking, "It is not sufficient to say under such and such conditions a current flows, or a resistance is increased. The practical electrician must know how much current and *how much resistance, or he knows nothing.*"—*London Elec. Rev.*



Allis-Chalmers Co., of Milwaukee, is issuing a bulletin on "Compound Corliss Engines," which contains, besides illustrations of each type, many facts of interest to power users throughout the country. "So far as we are aware," it is stated, "the first compound Corliss engine designed for power purposes was built in the shops of this company, and to our Mr. Edwin Reynolds, who for nearly half a century has been so prominently identified with the history of this type, should be given credit for introducing the principle of compounding into general Corliss engine practice. The earliest Corliss engine was built in 1848, and twenty-eight years later the famous "Centennial" engine, which was supposed to embody in its design and construction the very highest development of the engine builder's art, was nothing more than a pair of simple engines. The first Reynolds-Corliss engine, built in 1877, marked the beginning of an epoch in the history of the steam engine. The first compound Reynolds-Corliss was built three years later, and is still in regular operation."

Since then thousands of these engines have been put in service in electric railway and lighting power-houses; in large and small pumping stations; in blast furnaces and rolling mills; in textile mills, flour mills, and saw mills; in foundries, machine shops and woodworking factories; in newspaper and printing establishments; in office buildings; in technical schools and colleges; in all kinds of industrial plants at home, and in nearly every country in the world, Reynolds-Corliss engines have thoroughly demonstrated their good qualities, and its compound engines have contributed largely to the high reputation in which the products of Allis-Chalmers Company are held.

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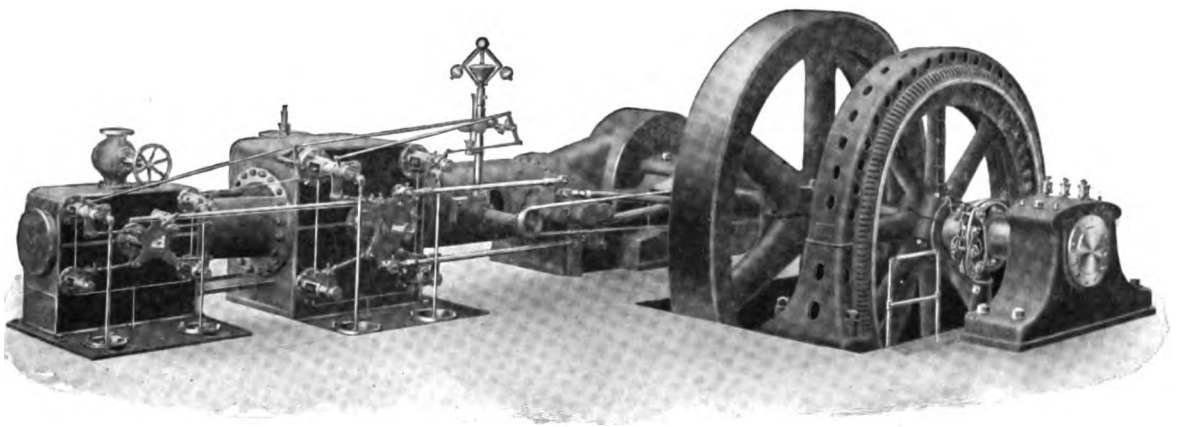
The strong argument in favor of the use of compound engines is their greater economy. The economy of the power plant as a whole is, of course, dependent upon the efficiency of boilers, furnaces, stack, etc., as well as upon engine economy; but, assuming the same efficiency of the other parts of the power plant, the economy of the engine will determine the relative amount of fuel required. Under the same operating conditions, a compound non-condensing, as compared with simple Corliss engine, will effect a saving of at least 20%, and a compound condensing Corliss will effect a saving of at least 40% in cost of fuel. There are few locations where the cost of fuel is so low that such saving will not, after paying good interest on the additional cost of the compound engine, afford a sufficient surplus to wipe out this difference in cost in a very few years.

The importance of this is not confined to the larger plants, for, although the comparative difference in cost may be somewhat greater in the smaller plants, the saving is still large in comparison.

There is a general though decidedly erroneous impression among steam users that no great advantages can be gained by compounding unless high steam pressures are used. While it is true that high pressures are conducive to economy in steam consumption, it is equally true that at lower pressures the percentage of saving by compounding is relatively very nearly as great, when engines are run condensing, as at higher pressures. It is true that a compound Corliss will be more economical at 150 pounds than at 100 pounds initial pressure, and it is also true that a compound condensing Corliss, when operating under 100 pounds initial pressure, will use 40% less steam than a simple non-condensing engine under the same pressure. In fact, the great economy of compound Corliss engines was demonstrated and their reputation established at a time when pressures higher than 80 pounds were rarely used. The economy of compound non-condensing engines is less marked at lower pressures, but even at 100 pounds initial pressure a compound non-condensing engine will effect a saving of approximately 15%.

To determine whether it is better to use a compound engine requires careful consideration of the commercial and engineering conditions in each particular case. The compound engine is unavoidably more expensive than the simple engine, against which must be offset the saving in cost of fuel and also in cost of boiler room equipment, owing to the smaller steam-making capacity necessary. The price of fuel and steadiness of operation of the plant have an important bearing in this connection, for, if fuel is inexpensive, or if the engine is to run only a few hours per day or for a short period each year, the annual saving may not warrant the additional cost of the plant. On the other hand, if the engine is to be run steadily the annual saving, even with low-priced fuel, will more than warrant the additional investment. The permanency of the plant is also a factor in the problem.

Whether a compound engine, if used, shall be horizontal or vertical, cross or tandem, condensing or non-condensing, must be determined by local conditions. Vertical engines cost more than horizontal engines of the same power, require less floor space and more head room, and are not used, as a rule, except in the largest sizes, or in smaller sizes only where the floor space is limited. Combined horizontal and vertical engines in many cases meet space requirements and operating conditions better



HEAVY DUTY TANDEM COMPOUND ENGINE, DIRECT CONNECTED TO ALLIS-CHALMERS GENERATOR.

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than either vertical or horizontal engines. Cross compound engines occupy somewhat less length and greater width of floor space than tandem engines having the same sized cylinders, have a more uniform turning moment, and, especially in the larger machines, are more convenient of access to the lower pressure cylinders and are more easily handled in starting and stopping. Condensing engines require an ample supply of water, of not too high temperature, for condensing the steam; the lower the temperature the less the quantity of injection or circulating water required. In many cases, where the supply of water is limited, it may be cooled in ponds or in cooling towers and used repeatedly. Where no water is available for condensing purposes, or where the exhaust steam can be profitably used for heating or drying, non-condensing compound engines may often be used to good advantage.

Allis-Chalmers Corliss compound engines are built in various types, styles and patterns, of any desired capacity up to 10,000 horsepower (or larger if wanted), and for any required service, from ordinary factory use to the heaviest and most severe electric power and rolling mill work; so that the intending purchaser has a wide field from which to make selections.

To secure the best result in reliability and efficiency, engines should be designed for the work they are to do and the conditions under which they are to operate. To this end, and to better enable its engineers to advise and assist customers in their selection, inquiries addressed to the builders of these machines should state:

1. For what service the engine is intended; if for mill or factory, what kind if for an electric plant, whether lighting or power, or both.

2. The minimum, average and maximum horsepower required.

3. Whether any provision must be made to provide for possible future increase.

4. Whether power is to be taken off by belts, ropes, or direct connection to engine shaft. If belt or rope drive, which is preferred. Give speed at which driven pulley on line shaft or machine to be driven must run and the horizontal and vertical distance between centers of flywheel and driven pulley, and whether belt or ropes will lead forward away from cylinders or back by cylinders.

5. Whether horizontal or vertical, cross or tandem engine is wanted. This may depend upon how the engine is to be located and the available floor space and it will help to a better understanding of what is required if a sketch is sent showing proposed location and arrangement of engine with relation to line shaft, machinery to be driven, boilers, etc. Sketch should give limiting dimensions, if any.

6. If engine is to be belted or direct connected to electric generator, give voltage and required output in kilowatts at full load and state whether alternating or direct current will be used. Also state whether machine is to operate in parallel with other units, and if alternating current, state frequency or number of cycles. Should also know the power factor under which generator is to operate. The company builds a full line of electrical machinery and can furnish complete units, with all auxiliary apparatus.

7. Steam pressure at engine throttle valve.

8. Whether condensing or non-condensing engine is wanted. If condensing, state vacuum in inches of mercury (referred to 30" barometer). If non-condensing, state whether engine will exhaust freely to atmospheres or against what back pressure it must operate.

9. What quanity of water for condensing purposes is available and at what temperature. Also give level of source of supply below or above floor of engine room. Condensing apparatus should be especially designed to meet the purchaser's requirements, and this Allis-Chalmers Company states it is prepared to furnish.

H. L. Hibbard, Electrical Expert to the Bureau of Construction and Repair, U. S. Navy Department, has resigned that position to enter the employ of The Cutler-Hammer Mfg. Co., of Milwaukee, makers of electric controlling devices. Mr. Hibbard's experience in navy yard and shipboard work extends over a period of eight years, four of which were spent in the office of the Superintending Naval Constructor at Newport News, in supervising installations of electrical apparatus on ships built and equipped at that yard. More recently, Mr. Hibbard has been stationed at Washington, where as Electrical Expert to the Bureau of Construction and Repair, he has had supervision of all electrical work coming under the cognizance of that Bureau. In his new position with the Cutler-Hammer Mfg. Co. his thorough knowledge of Navy Department requirements and methods will undoubtedly be of great value in the further extension of that company's line of electric controlling panels for Navy Yard and shipboard use.

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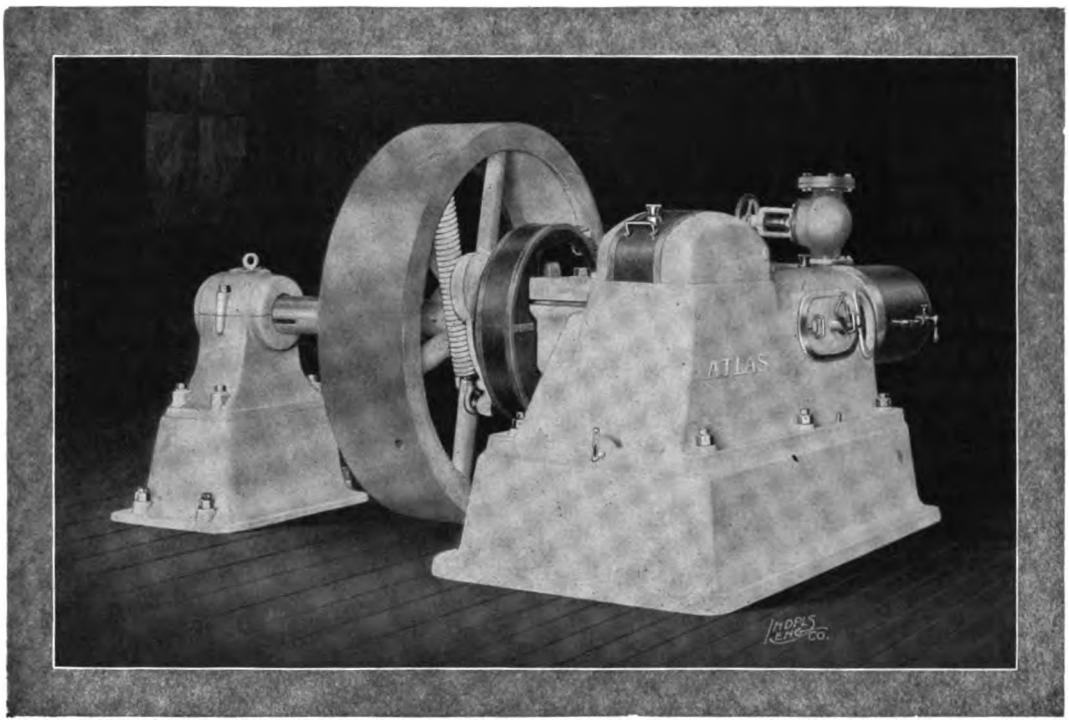
Atlas Engine Works, of Indianapolis, Ind., the largest exclusive engine and boiler makers in the world, have just issued a new bulletin No. 137, describing their splash oiling, single valve, high speed engines which are now being built in sizes from 50 to 250 h.p., and especially designed for direct connection to electric generators, and other classes of work requiring high rotative speed, with perfect regulation throughout wide changes of load.

This engine conforms to the standards established by the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers as to speeds, sizes of units and sizes of shafts.



ATLAS SPLASH-OILING SINGLE-VALVE HIGH SPEED ENGINE.

As all parts of this type of engine are built from jig and templates, on the interchangeable plan, uniformity of size in every particular is thus assured.

These engines are built throughout with a very large factor of safety, and are designed to safely carry a steam pressure of 150 pounds.

The above company has adopted the side crank type, so as to avoid the undesirable feature of an overhanging wheel, having reference particularly to belted engines, and because of its superior adaption for direct connection to direct or alternating current generators. In this type of side crank engine, there are but two bearings to keep in alignment, while in the center-crank engine there are, of necessity, three bearings, with unequal wear, which are apt to give trouble, unless the most vigilant care is exercised.

The bed plate is massive and solid in design and cast in one piece, entirely enclosing all the reciprocating parts of the engine.

The cylinder is made of clean, close-grained iron, of a special Atlas mixture which readily takes on that high polish which insures long service with the least wear. The valve is a balanced slide valve, which slides over the ported valve seat, and is covered its entire width and length by a heavy pressure hood.

In providing a system of lubrication, careful consideration has been given to the maintenance of a clean engine, with the result that they have adopted the splash system, embodying in it some special features, the result of long experience in construction. The crank case is enclosed with an oil-tight hood hinged to the bed frame, giving easy access to the crank pin. Babbitt metal is poured around the hood to fill up the imperfections of the castings, thus making for the hood a tight joint. The fan-tailed crank, at each revolution, dips into the oil in the crank case, splashing it to all parts of the interior of

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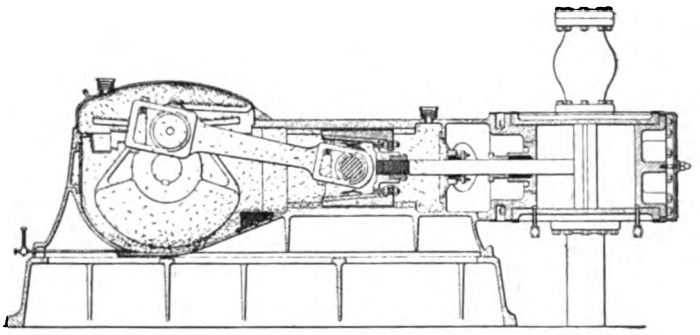
the bed frame. The crank pin is oiled by a drip from the hood dropping into a pocket on top of the connecting rod. A portion of the oil running down the side of the hood encounters internally projecting flanges, which conduct the oil to the main bearing and also to the eccentric by means of a pipe, where the flow is regulated by sight-feed cocks. The eccentrics are enclosed, and the oil is thus returned to the crank pit. The cross-head has a funnel in the top to collect the oil, and directs a constant flow to the crosshead pin. A perforated brass frame, filled with filtering material, is placed in front of the guide through which the oil passes in returning to the crank pit, thus removing all particles of grit or dirt. A diaphragm in the frame near the cylinder end, and provided with metallic packing, fitted to the piston rod, prevents the condensation from the cylinder stuffing box mixing with the oil.



SECTION OF ATLAS ENGINE SHOWING SPLASH-OILING SYSTEM.

The Western Electric Company reports largely increasing business in the Sunbeam Tantalum lamp. Many users are substituting this lamp entirely for the old style carbon filament lamp. It is interesting to compare the service of these two lamps. The Tantalum gives 20 c.p. and consumes only 40 watts, whereas the regular lamp gives 16 c.p. and consumes anywhere from 56 to 64 watts. While the first cost of the Tantalum lamp is much higher, the saving resulting from its use will very soon more than pay its entire cost. The light produced by the Tantalum lamp is of a much whiter and more beautiful quality than that of the old type lamp and it has been the general experience that those who once try these lamps are not satisfied to use any other thereafter.

During the past two months more than 125,000 Tantalum lamps were ordered for the sole purpose of replacing an equal number of old type carbon filament lamps, which in itself is a very significant fact. It means that the Tantalum lamp is to play a very important part in the future of electric lighting.

The Western Electric Company will be glad to quote prices and discounts upon application. They have offices and stock in all large cities.

Messrs. McKenney & Waterbury Co., 181 Franklin corner Congress street, Boston, Mass., have on exhibition in their show rooms an entirely new line of electric table lamps, in Amboy art glass and arts and crafts designs, and they invite all lovers of art to visit their show rooms during the coming week, where they will see the most artistic and largest assortment of lighting fixtures in the country.

Some months ago, The Cutler-Hammer Manufacturing Company, of Milwaukee, Wis., announced the purchase of the Wirt Electric Co., of Philadelphia. They now state that they have consolidated the Wirt business with that of their New York plant at Park avenue and 130th street, where the manufacture of Wirt apparatus will be continued.

Information concerning Wirt apparatus may be obtained from any of the branch offices of The Cutler-Hammer Manufacturing Company, who respectfully solicit such inquiries and the continued patronage.

All outstanding accounts due to the Wirt Electric Company should be remitted to the general offices of The Cutler-Hammer Manufacturing Company, at Milwaukee, Wis.

Allis-Chalmers Company, of Milwaukee, has been awarded the gold medal for electric generators and motors, issued by the authorities of the Jamestown Exposition, as determined by a jury of well-known technical experts representing leading electrical interests of the country. A second gold medal has also been granted for the good judgment and taste shown in the design and erection of the exhibit, which has been one of the most attractive features of "Machinery Hall." Gold medals have previously been taken by electrical apparatus of this company's build at the Louisiana Purchase Exposition, Paris Exposition, and other exhibitions where there was international competition.

Chase-Shawmut Company, of Newburyport, Mass., has just issued catalogue and price list No.

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101, illustrating and describing their stage-lighting appliances.

This is a continuation of a series of bulletins this company is now getting out, the bulletin No. 100 having recently been issued, covering National Electrical Code fuses, cut-outs and fittings, railway cut-outs, boxes and pocket test lamps.

When John Wanamaker built his new store in New York City, the Pittsburg Gage & Supply Co., Pittsburg, Pa., equipped his power plant with a White Star Continuous Oiling System. This installation having proved its usefulness, Mr. Wanamaker has just ordered a duplicate system for his Philadelphia store.

The Pittsburg Gage & Supply Co. are also furnishing the Lackawanna Steel Co.'s, Lackawanna, Pa., plant with its third system.

The Pittsburg Gage & Supply Co. have just moved into their new seven-story factory, where with unlimited facilities they will be better able than ever to fill orders promptly. It might be said that their new plant is the largest and most complete one of its kind between New York and St. Louis.

The Zoar Storage Battery Company, of Zoar, Ohio, has just issued a very attractive sixteen-page illustrated circular, describing their central station type, vehicle type and spark type of storage batteries. The illustrations in this circular show not only the highest developments in the art of storage battery construction, but many substantial features of construction which are distinctly "Zoar." Their batteries in all styles are made to comply with standard requirements, and owing to their long experience in this work are especially prepared to make up special batteries of cells for any required service. This new circular will be sent to any reader of THE CENTRAL STATION who will write for it.

Mr. Edward E. Scribner has recently joined the sales force of the Holophane Company. His work will be among architects whose interest in the Holophane System of Illumination has grown to such proportions as to warrant the company in detailing a special representative to serve them. Mr. Scribner's headquarters will be New York City.

The Electric Sad Iron Co., a new manufacturing company, organized and operating in Detroit, Mich., has just placed upon the market their "Superior" flat iron, designed to meet the demand for general household, laundry and manufacturing purposes.

The "Superior" iron is of a new and pleasing design, six pounds in weight, "V" shaped, handsomely finished either in nickel or aluminum, and possesses certain novel features which make it a most efficient iron in every way. The weight and balance make it easy to handle while working and the arrangement of parts is such that the electrical units are converted into heat units with the least possible percentage of loss.

The heating element is the vital part of any electrical heating device and upon it depends the efficiency of the iron. The manufacturers of the "Superior" have discarded wire as a heat generating resistance, owing to its rapid disintegration. An element is used and arranged in such a way as to come into the closest possible contact with the bottom plate or ironing surface and to cover it at all points. This means that the heat generated is directed into the bottom, where it is needed, and is not wasted in heating the handle of the iron or the air of the room. It also means that the same temperature is maintained at all points of the ironing surface. The sides and point of the ironing surface are always as hot as the middle. This feature appeals most strongly to any user of a flat iron. In case it is necessary, the heating element may be easily and quickly removed, and another one inserted without delay, thus saving time and trouble.

In constructing the "Superior" the manufacturers have provided an iron which will heat very quickly to the working point. It, however, does not lose its heat quickly, as the heating element and body of the iron are heavy enough to hold and give off all the heat necessary for the heaviest work. No annoyance is caused by sudden changes of temperature.

In case the iron becomes too hot, and for other purposes, a detachable conducting cord is provided with every iron. The detachment is made at the iron by an insulated plug, specially designed, which slips on and off of the iron.

With each iron is also provided a heat insulating stand, so made that no matter how hot the iron becomes or how long it remains on the stand, no heat is conducted to the material on which the stand rests.

A coil spring is also provided which supports the cord and keeps it out of the way of the operator

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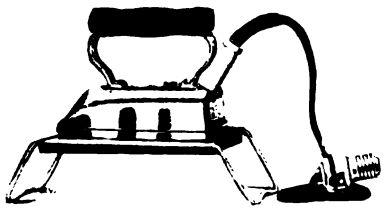
and insures the longest life to the conducting cord, which is itself made specially strong and durable.

These features make the "Superior" iron convenient and economical of operation. It appeals to the user and hence to the dealer and central station manager. The Electric Sad Iron Co. reports a most



ELECTRIC SAD IRON.

satisfactory sale of the "Superior" already, and that it is showing splendid results.

Announcement has just been made that Jordan Bros., 74 Beekman street, New York City, have been awarded a silver medal diploma for their exhibit of the Jordan Commutator Truing Device at the Jamestown Exposition, 1907. This award is the highest in its class. As is well known, the Jordan Commutator Truing Device trues commutators without removing the armature from dynamo or motor. The device can be attached to any machine. It consists of a grinding wheel set in ball bearings

JORDAN COMMUTATOR TRUING DEVICE.

and equipped with appropriate clamps whereby it can be fastened to a rocker arm or the motor frame, or the out-board bearing, according to the type of the dynamo or motor. The grinding wheel is of carborundum, contains no emery and so cannot injure the commutator.

Operation is as follows: The device is bolted in position so that its shaft is parallel to the face of the commutator and the grinding wheel just clears the commutator. It saves labor and time and increases life of commutator three-fold.

Meter Testing

Periodical meter calibration is of vital importance to every central station and although there is no question regarding the accuracy of making the test with indicating instruments, it is important that some means be provided by which without decreasing their reliability the tests can be made more conveniently and quickly. The Thomson high torque induction test meter described in Bulletin No. 4549, recently issued by the General Electric Company, Schenectady, N. Y., is intended for this service and consists of a Thomson induction meter registering revolutions of the disk instead of having a dial giving the kilowatt hours. The meter also contains current coils of different capacities so that by connecting each in circuit successively, a wide range of capacity for the tests is obtained while using the meter near the full load of the different coils. The test meter is connected in series with the meter under test, and a comparison made of the respective number of revolutions of the two disks in a given time. A simple calculation reduces the results to watt hours for the two meters and the percentage of error, if any, in the meter under test is quickly determined. Accuracy is maintained in the test meter by simple calibrations and the parts are readily accessible. The bulletin contains a description of the method of operation and diagram showing method of making the test.

Direct Current Indicating Instrument

Direct Current Indicating Instruments, Type D, manufactured by the General Electric Company, Schenectady, N. Y., are constructed upon the well-known. D'Arsonval principle, and designed for switchboard use. Bulletin No. 4552, recently issued by the company, describes and illustrates their construction, and gives dimension diagrams of instruments and shunts, full-sized views of the scales, and data regarding catalogue numbers. capacities, prices, etc. Damping is obtained by means of Foucault currents generated in an alumnium frame on which the coil is wound. The magnets are carefully hardened and aged, and an unusual high torque, combined with light moving elements and small magnetic air gap, make reasonable the manufacturer's claim of long life with continued accuracy. The frame is pivoted in a jewel bearing and the whole assembled in a round cast-iron case which protects it from stray fields and renders the instrument dust proof. The standard finish of Type D instruments is dull black with raised portions of polished copper.

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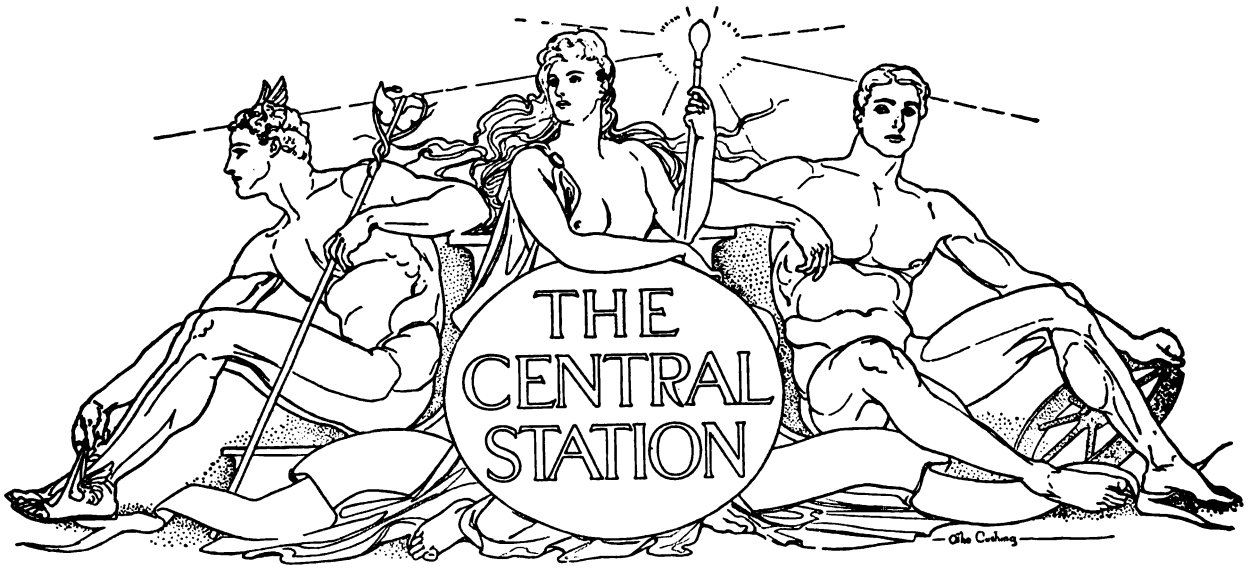

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

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Central Station Light, Heat and Power Principles

BY NEWTON HARRISON.

Switches.—The means employed for breaking, and conversely, making a circuit, by the use of a switch, have developed along scientific and engineering lines. In consequence of this, the conditions met with during either operation, have been subjected to careful analysis, and the conclusions drawn, embodied in the various types of switches the market affords. Switches may be purchased for currents of different characters with the necessity implied, that they serve a distinct purpose.

For instance, switches may be considered in a general way, as belonging to some such category as the following:

1st—Switches for small currents.

2d—Switches for large currents.

3d—Switches for low pressure.

4th—Switches for high pressure.

The question of expediency in opening or closing the switch, belongs to the second set of considerations, pertaining to the practical construction of switches in general, which may be included under the following headings:

1st—Switches hand opened and opening slowly.

2d—Switches spring opened and breaking swiftly.

3d—Switches automatic in operation.

The names given to switches which open and close circuits of defferent characters naturally relate to these circuits. For instance, there are snap switches for electric light circuits of limited current which are divided up into two types as follows:

Single pole or single break switches.

Double pole or double break switches.

It is evident from this brief presentation of a few of the circumstances relating to switches that the amount of current in the circuit, and the potential, are the two important factors determining the design of the switch, whatever may be its point of application in the system. The fact that one or two points of the circuit is broken, or even more, in order to safely discontinue the current, is simply an evidence of the need existing for a design in this respect, which embodies, at least these features:

ELEMENTS OF SWITCH DESIGN.

(a) Sufficient carrying capacity to conduct the current without heating.

(b) Low enough resistance to cause a negligible drop in pressure.

(c) Enough breaks to avoid risk in arcing in opening the switch.

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(d) A quick action in opening, by which burning is avoided at the last parts to disconnect.

(e) Parts substantial enough to stand handling without deterioration.

(f) Current passes through no springs, whose elasticity is affected by this fact, and the action of the switch imperiled thereby.

Other considerations govern the designer in laying out the parts entering into service, but aside from the questions of pressure and current, durability is the item of greatest practical importance.

What Is a Switch.—A discrimination is made by a large electrical company, between two general types of switches, as follows: "The term switch is given to those pieces of apparatus in which the contacts are similar to the ordinary switch, and are opened and closed by hand. Apparatus in which the contacts tend to separate and are only held in a closed position by means of triggers or toggles, which are called 'circuit breakers.'"

The general proposition that a circuit is broken by a hand operated or automatic device, covers the definition of a switch, along practical lines, whether it is hand operated or automatic, in either opening or closing its utility is governed largely by its durability, other things being equal.

Switches for Small Currents.—The types of switches used for small currents belong to the category of quick break single and double pole. The conditions prevailing in electric light service, within the structure to be lit, are such that fire risks have had a determining effect upon the general design of such switches. The Underwriters have outlined in clear, practical terms the amounts of current suited to certain circuits, and the switches in consequence are designed with reference to this particular service.

The predisposing factors in all such instances are naturally the amount of current and the potential. The number of breaks, the heaviness of the parts, the quickness of action, and the size and convenience of the switch as a whole, are governed by the requirements of the current and service.

Voltage and Length of Break.—The circuular miles allowed for various currents, determine the cross sections of parts of the switch, particularly as regards the drop in its parts, and the temperature, as a whole. But the speed of breaking and the distance between the parts broken, to insure safety from arcing requires separate treatment. In alternating current service it is evident that the power factor plays an important part in the design of a switch, for the reason that the arc will be able to lengthen at the point of break in proportion to the inductive electromotive force behind it.

If the inductance is low or zero, the conditions are practically normal; but the pressure of inductions and its effect in lengthening the arc unduly, calls for distances between points that break, that are far greater than would be ordinarily accepted as correct. A series of experiments with high static pressures gave rise to the following results regarding not only distance, but the ability of the spark to leap the gap presented:

Pressure in Volts Between Terminals Jumped by Spark.	*Distance in Inches.*
4,765	.04
8,140	.08
11,307	.12
14,119	.16
16,664	.20
19,210	.24
21,823	.28
22,792	.32
24,153	.36
25,071	.40
26,255	.44
27,024	.48
27,765	.52
28,359	.56
28,949	.60
29,363	.64
29,837	.68
30,133	.72
30,547	.76
30,932	.80
31,198	.84
31,494	.88

Requirements of Switches in Practice.—The requirements of switches for high and low pressure service may be enumerated for reference in the following list of items:

SWITCH REQUIREMENTS IN SERVICE.

1st—Switches must break at a pressure of from 20,000 to 60,000 volts.

2d—Switches must be safe and sure in operation.

3d—Switches must not burn contacts under any circumstances.

4th—Switches must have perfect contact between parts that touch.

5th—Switches must have a high efficiency, wasting very little power.

6th—Switches must have low heating, secured by ample cross sections.

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7th—Switches must have interchangeable parts, thus securing a ready means of continuing the service in case of injury at this point.

8th—Switches must be constructed of non-combustible material, and thus lower the fire risks to a minimum in connection with them.

9th—Switch parts must be capable of ready inspection for the easy discovery of faults in case they are developing under severe service.

10th—No exposed metal parts, thus removing the likelihood of and freedom from accidental contact with conductors of any description.

11th—Safety to attendants, through the systematic inspection of the switches, and their design such that this is readily accomplished. .

The general proposition that even low pressure switches must be able to break a much higher pressure than they are used for is nothing but sound practice. Disregard of this rule in any department of engineering is fatal to success. The fact that the rating of a machine or device is such that when in operation it has no safety factor or leeway to rely upon for emergencies, condemns it at the outset.

The rating of switches, therefore, must be made on the basis of normal service with a reserve capacity far exceeding this value in amperes and volts. For instance, a 25 ampere switch must have more than 25 amperes capacity at a pinch; a design to suit a 115 volt pressure must be capable of useful service if necessity arises of more than this pressure. How much more is at the option of the manufacturer.

Calculation of Drop in Switches.—The drop in switches is due to the current having unduly heated it, insufficient cross-section to parts, or poor contacts between parts or surfaces carrying current. The drop in volts due to a current of 100 amperes may be noted as follows:

Current.	*Resistance.*	*Drop in Volts.*
100 amperes.	.001 ohm.	0.1
100 amperes.	.005 ohm.	0.5
100 amperes.	.010 ohm.	1.0
100 amperes.	.050 ohm.	5.0
100 amperes.	.100 ohm.	10.0

The circular units per ampere are allowed on the basis of the resistance and temperature rise. For ordinary circuits, the allowance of circular units in the conductor cross sections is based upon the drop. For instance, if a No. 10 B. & S. wire is required in a case where a two volt drop occurs, then a No. 7 B. & S. would be required in the same case if a one volt drop was required. In switches the basis of calculation is the same as far as the drop goes. For instance, if the drop between the terminals of a switch is to be one-tenth or one-twentieth of a volt, the resistance would then depend upon the amperes or the capacity. The circular mils would then be founded upon this resistance in turn.

In the case of 100 amperes and a one volt drop, the resistance is necessarily .001 ohm. The fact that a mil-foot of copper is about 11 ohms, would mean that a switch in which the current traverses twelve inches of equivalently good conducting metal must have a minimum cross section of 11,000 circular mils; if six inches a cross section of 22,000 circular mils; if three inches, a cross section of 44,000 circular mils. If the safety factor is twice the rated capacity without heating, then the points of contact must have doubled cross section again, or 88,000 circular mils, etc. In other words, the temperature and capacity govern the cross section of current carrying parts in every instance.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability for Death or Injury from Electric Current, Continued—Duty and Liability to the General Public—Wires in Highways, Continued

In the last article we began the discussion of who was liable for injuries by electric wires and the extent of that liability, and in this article we propose to continue that discussion confining our at-

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tention most particularly to the consideration of who is liable for an injury sustained by reason of negligence with reference to poles and wires used for carrying electric currents.

Both companies are liable where a telephone wire is suffered to remain over a trolley wire in a street when the trolley wire is not guarded and when the condition of the telephone wire would arrest the attention of a prudent man engaged in the business of both companies.

United Electric Ry. Co. vs. Shelton, 89 Tenn. 423, 14 S. W. 863.

Likewise inasmuch as a city is bound to maintain its streets if it permits an electric light company to erect poles and string wires in the streets it will be held liable jointly with the light company if a wire remains down in the street for so long a time as to impliedly charge the city with notice of the condition.

Kansas City vs. File 60 Kansas 157, 55 Pac. Rep. 877.

A rather interesting case arose in New York which although not subject to discussion here, nevertheless involves a principle of importance to all companies interested in this branch of the law. In this case defendant's employees were engaged in stringing a cable. Boys were playing about the street and one of them stepped across the cable. Just at that moment the cable was stretched and the boy was thrown some twenty feet into the air, sustaining severe injuries. The company was held liable.

Devine vs. Brooklyn Heights Ry. Co., 1 App. Div. 237, 37, N. Y. Sub. 864.

A telegraph company will be liable for injuries sustained by a pedestrian coming in contact with a wire which its employees left hanging in the street in contact with wires of an electric light company or street railway company.

Henning vs. Western Union Telegraph Co., 41 Fed. Rep. 864.

It is the duty of telephone or telegraph companies and electric companies where their lines parallel or cross each other in such manner that one wire is liable to fall on the other, to see to it that proper guards are placed so that in case of accident to either wire cause it to fall it will not come in contact with the wires which remain, and if such guard is not placed and the upper wire which normally carries the harmless current, falls on the lower wire, which carries a deadly current, and a boy accidentally strikes his foot against the fallen wire and is killed, both companies will be held liable, even though the breaking of the telephone wire was caused by a storm, the ground of the liability being the failure to install a cradle or guards to prevent contact of the wires in case of accident.

Rowe vs. N. Y. & N. J. Telephone Co. 66 N. J. Law 19, 48 Atlantic Rep. 523.

This same case is also authority for the proposition that notwithstanding the fact that telephone wires were first in position, having been placed before the electric wires were strung that it is nevertheless jointly liable, being under the same obligation as the electric company which occupied the street last on the ground that every person using the highway is bound to exercise reasonable care to protect others from harm through this user. In case this use is continuous, the degree of care required will not be governed by the condition of the highway at the time the use began, but will change as that condition changes and must keep pace with the circumstances as they occur. When, therefore, an electric company under legislative sanction places other structures in the city street, a new state of things appears, with reference to which the degree of care from telephone companies must be gauged.

Where a telegraph company and an electric light company both maintain wires in the street it is the duty of the electric light company to use reasonable care, that uninsulated telegraph wires which cross the electric wires should not be allowed to come in contact with the electric wires which are insulated and which carry a wonderful electric current, and remain for so long a time in contact there with it as to wear away the insulation from the electric wire and divert the strong current to the telegraph wire, causing injury to persons who might come in contact with the telegraph wire or with wires in contact with it.

This duty also extends to where the injury is caused by reason of contact with a third wire which received its current from the telegraph wire that was in contact with the electric light wire and to the company which owns the third wire, and it is the duty of all three companies to see to it that such contact is not established so that injury will be sustained and for that purpose to use reasonable care to prevent other lines from becoming out of order and to prevent contact with high tension electric wires.

Hamilton vs. Bordentown Electric Light Co. 68 N. J. Law 85, 52 Atlantic Rep. 290.

A telegraph company which maintains a cail wire and permits it to remain in position after it has be-

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come defective through age and rust so that it breaks and falls upon a highly charged electric wire will be liable for the death or injury of one who comes in contact with the broken call wire.

Western Union Teleg. Co. vs. Thorn 12 C. C. A. 104, 64 Fed. Rep. 287.

EXCUSES FROM LIABILITY.

The liability of an electric light company for injuries or death caused by a current in one of its wires in a street may be relieved by the presence of one or two ultimate facts, the absence of negligence on its part and contributory negligence on the part of the person killed or injured. If the proof is favorable on either one of these points the electric company is relieved from liability, and we have to deal first with the fact that the company was not negligent.

It will be recalled that neglect of a duty owing to the general public by an electric company is the foundation of all liability in this field, we have learned that this duty is owing to the general public and its limits have been outlined. It now is to be considered what relieves its obligation or rather what causes of injury are not within the scope of breach of duty, it is true that an electric company is practically bound to see to it that its lines of wire, poles, and other paraphernalia are in sound condition and subsequently negligence is presumed as against the wire line company from the fact that its wires are down in the street.

Haynes vs. Raleigh Gas Co. 114 N. C. 203, 26 L. R. A. 810, Western Union Telegraph Co. vs. State 31 L. R. A. 572, Larson vs. Central Ry. Co. 56 Ill. App. 263.

Liability for Injury To Children—Electric Wire—Contributory Negligence

A decision of the Supreme Court of Nebraska upon the nature of the liability of an electric company, which has permitted a wire heavily charged to remain close to the ground outside of the highway, is unique and contains much important decision of the general principles involved in such cases. The followiug is a portion of the opinion: "There is in our view nothing in the nature of an electric light wire, placed eighteen or more inches outside a public highway and defended by a substantial fence four feet high, which would lead a person to suppose that is attractive to children of tender years as a plaything, and there is no evidence that the defendant know or apprehended the wire in question to be so. Decided cases involving the right of children of tender years, or their parents or guardians to recover for the consequences of negligent injuries, fall into several classes. One of them is of those instances where the child is employed or is rightfully present in a place of danger, and does or omits an act or acts which in a person of mature years and ordinary experience and intelligence would be admitted negligent, but for which conduct the child, on account of his supposed lack of these qualities, is either absolutely excused, as a matter of law, or the degree of his incapacity or lack of discretion, and consequent irresponsibility, is left to the jury as a question of fact. The line of discrimination between these two subdivisions, in one of which the jury is disposed of as a matter of law, and in the other of which it is treated as a question of fact, is extremely obscure and uncertain, if there can be said to be any such distinct line, and its discovery in every instance is largely dependent upon the peculiar circumstances of the particular case, and perhaps upon the unconscious bias and preconception of the court who decides it. But with neither of these subclasses, or with their definition, have we now anything to do. Another class of cases is composed of instances in which the party by or on behalf of whom the complaint is made was not an employee or rightfully present, and was one toward whom the person owning the instrument inflicting the injury owed no duty except to abstain from malicious or wanton misconduct. Ordinarily, in such cases, if the person injured is an adult, the question of negligence or of contributory negligence, property speaking, does not arise, the trespasser assumes the risk of his own conduct, and no liability exists. But, if the person injured is of immature years, several questions arise, all of which, to justify a recovery, must be answered in the affirmative: First, is the machine or appliance of such a character as to be generally known, or was it or should it have been known to the proprietor, to be likely to inflict the same or similar injury if unguardedly dealt with? Second, was it of such a character that a reasonably prudent man would have known, or did the proprietor in fact know, that it was of such a character as to attract or induce young and indiscreet persons to employ it as a plaything, in mental obliviousness, or nearly so, to their peril in so doing, or at least of the nature or degree of such

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peril? And, thirdly, was the party injured of the description last given? Obviously the last question may be solved in one of the two ways. Either discretion or indiscretion may be conclusively presumed as a matter of law, from the age and experience of the child, or the age may be regarded as raising a presumption susceptible to rebuttal by evidence. And here, too, the authorities speak with no certain or unequivocal voice. We think it would render this opinion uselessly prolix to make an attempt, necessarily fragmentary and imperfect, to cite and criticize the hundreds of reported decisions treating of this and allied questions. A comprehensive and masterly collection and review of them may be found in sections 306 to 349, both inclusive, of the first volume of Thompson's Commentaries on the Law of Negligence.

It seems sufficient to refer to that work and to state our own conclusions as to the principles deducible therefrom and as to their application to the pending case.

One inference from these decisions seems to be quite clear, and that is that the rules of law and practice relative to the weight, sufficiency, and conclusiveness of evidence with respect to any of the foregoing questions, in cases in which they are to be decided upon evidence, are not different from such as are applicable to the trial of other issues. Now, we are far from assuming, in the absence of proof, that an electric light wire situated as was the wire of defendant is an object of such a nature, or is so generally known to be such that the defendant must be presumed to have known it so to be, as to attract and induce children of tender years, or boys of ten or twelve years of age, to make use of it as a plaything. Neither do we think the evidence sufficient to prove that the defendant had such knowledge, or that the wire was in fact of such a nature. So far as our own observation goes, or legal literature discloses, the casuality complained of was singular and peculiar. The circumstances of the former mishap are unknown, and it is a matter merely and wholly of conjecture whether it occurred in circumstances like those in the pending case or otherwise. And one swallow does not make a summer. Even if the circumstances had been shown to be similar, the defendant might have been excused from apprehending, because of its knowledge of one such happening, that so singular and improbable an event would be repeated, and have been permitted to rest securely upon its knowledge that its wire, though the insulation was slightly impaired, was so guarded as to insure the safety of the traveling public and of all others who had a right or could be expected to meddle with it. But the circumstances of the accident themselves are such that all these questions may be resolved in favor of the plaintiff and still there can be no recovery. There were five boys in the party. One of them climbed upon the fence as if to touch the wire, but his companions "scared him down." Then the plaintiff's son climbed partly up the fence apparently with like intent, and his companions "scared him down." Then he told them to go on to one side so as to be out of the way if he happened to fall and then he climbed up again and touched the wire, and received the shock and consequent injury, of which complaint is made. The evidence establishes several things without contradiction and conclusively. Electricity is a mysterious power, but in many of its manifestations is not, and has not been for many years, an unknown force. It is a matter of common knowledge that electric light and power wires carry powerful and death-dealing currents, and that they are the frequent cause of severe and fatal accidents, and that ordinary prudence requires all persons to avoid contact with them, especially if they are imperfectly or defectively insulated. The evidence establishes conclusively that the plaintiff's son was an ordinarily bright and intelligent lad, twelve years of age, who lived in the city and knew that the wire carried a current sufficiently powerful to light the circuit of which it was a part, and knew that, because of defective insulation or other defect at the place in question, such current was capable of being diverted into the body of any person coming in contact with it, and knew that shortly before that time it had been so diverted, and had thereby caused a shock or injury more or less serious to the person of another boy. That he anticipated an injury of some degree to himself is undeniable, because what he deliberately sought was a "shock," which is nothing less than injury. Whether he also anticipated its extent or degree is not known, but that he supposed that it would be of considerable severity is shown by his caution to the other boys to stand out of danger in case of his fall.

We know of no rule of law to the effect that, when one is negligent in a situation of danger the existence and nature of which he knows, he may nevertheless recover damages because the resulting injury is greater than he anticipated.

Johnston vs. New Omaha Thompson-Houston Electric Light Co. 113 N. W. Rep. 526.

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A Novel Single Phase Motor Installation

The three-phase induction motor has long held an enviable position in the operation of all classes of machinery on account of its excellent starting characteristics and its ability to give constant and reliable service with a minimum of attention and repairs. The single phase motor on the other hand has not been so fortunate in gaining the attention of both manufacturers and power stations on account of its poor starting characteristics, and for years the manufacturers of single phase motors

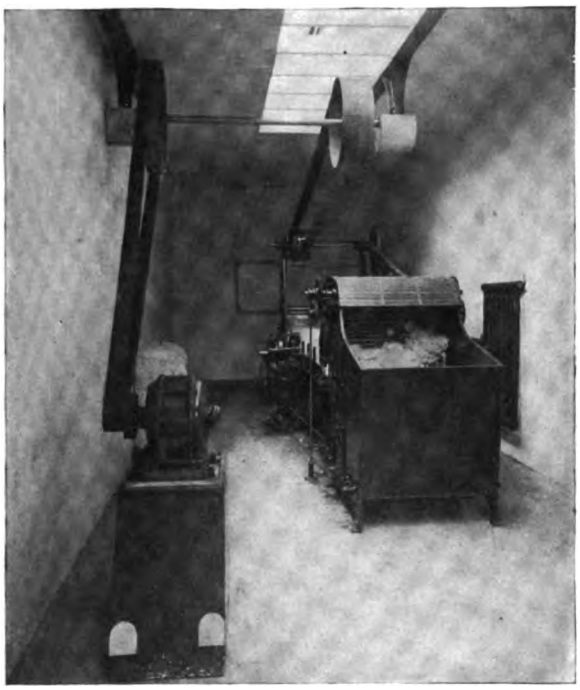

FIG. 1.—PICKER DRIVEN BY 7½ H.P. 220 V. KG. SINGLE PHASE INDUCTION MOTORS.

have centered their efforts on the production of a motor having all the desirable features of the polyphase motor.

The General Electric Company has perfected a single phase motor that is remarkably free from the defects usually found in single phase motors and which bids fair to become a successful competitor of the polyphase motor in the field of small motor-driven machinery.

For the driving of textile machinery the inherent advantages of the three phase induction motor have long been known and appreciated, but while their use has been confined to the operation of mills supplied with polyphase current from either central power stations or isolated plants, the advent of the single phase induction motor has opened up a new field for the textile industry, viz: the operation of mills in the suburbs or sections of the city supplied only with single phase current for lighting purposes.

FIG. 2.—DRAWING FRAMES DRIVEN BY 10 H.P. 220 V. KG. SINGLE PHASE INDUCTION MOTORS.

An interesting example of the application of single phase motor to the operation of textile machinery and one that is worthy of notice, is found in the factory of the Ayvad Manufacturing Company, of Hoboken, N. J. The product of this company is the well known "water-wings," a device used by bathers and beginners in swimming to assist in floating the body. The style of drive used

FIG. 3.—SPINNING FRAMES DRIVEN BY 10 H.P. 220 V. SINGLE PHASE INDUCTION MOTORS.

throughout is what is commonly known as the "group drive," in which a number of machines are driven by a motor from counter-shafts. The electrical installation, consisting of nine single phase induction motors of a total capacity of 75½ horse

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power, was furnished by the General Electric Company. The type of motor used is one recently developed by the above company for operation on single phase circuits and is known as the Form "KG."

FIG. 4.—LOOMS DRIVEN BY 10 H.P. 220 V. KG. SINGLE PHASE INDUCTION MOTORS.

The conditions influencing the final decision in favor of the single phase alternating current motors, were that the factory was located in a part of the city supplied with single phase alternating current for lighting and that the motors used operate without affecting the lights on the same circuit; also that all sparking of motors must be entirely eliminated. This last condition is one peculiar to textile mills, for in the early stages of cloth manufacture, the cotton is in a highly inflammable condition and the least spark might start a disastrous fire. A thorough investigation of the single phase motor finally selected satisfied the manufacturers that all conditions were met in the design of the motor, all commutators and brushes being eliminated.

Until this year, the practice of the Ayvad Manufacturing Company was to buy the cloth used in the manufacture of their product, from textile mills, their factory converting the fabric into the finished product. Since it was impossible to properly inspect every yard of the cloth for flaws, there often resulted a product of inferior quality. Delays in shipment and in transportation further added to the difficulties of manufacture.

To avoid all delays and to insure a good uniform quality of cloth a complete textile equipment from picker to loom was installed. The textile equipment now enables them to operate the factory during the entire year, where heretofore only six months' operation was sufficient to supply the demand. Any excess of cloth produced forms a profitable side line. The factory when in full operation will furnish employment for about sixty persons, and will require an average of about 5,000 pounds of cotton weekly.

The different views shown below will give some idea of the adaptability of the single phase motor to the driving of textile machinery.

Fig. I.—The view of the "picker" room as shown in Fig. I gives the method of counter shaft connection to the motor. The power required for running the "picker" is about 7½ horse-power. The "picker" room was built as an annex to the main factory and to provide sufficient light for working, a skylight was placed in the roof and the wall painted white.

Fig. II.—The two 10 horse power motors shown in Fig. II drive separate line shafting from which is driven the carding machines, drawing frames, roving machines and fly frames. In this same room the lines from the power circuit enter through the necessary switches, protective devices, measuring instruments, etc.

Fig. III.—In Fig. III is shown a view of the spinning room and two of the three 10 horse power motors, driving twelve spinning frames with a

FIG. 5.—PONY CYLINDER PRINTING PRESS DRIVEN BY 5 H.P. KG. SINGLE PHASE MOTOR.

total capacity of 3,000 spindles. The third motor, not shown in the view, drives a "spooler" and one warp machine. All motors are installed on plat-

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forms suspended from the ceiling and drive the spinning frames through countershafting. Sheet iron arches over the passageways protect employees from accidental contact with the belts. In the background of the picture may be seen the starting boxes for the motors. All the starting boxes are installed on slate panels with a backing of sheet asbestos.

Fig. IV.—In the view of the loom room shown in Fig. IV may be seen the 10 horse power motor driving the looms. It was calculated that about 7½ horse power would be required to drive the looms and a "slasher" not shown in the view. This leaves an ample margin in addition horse-power should it be found necessary to install other looms.

Fig. V.—The 5 horse power shown in Fig. V drives a "pony" cylinder printing press, also line shafting from which are driven cutting presses and other special machines used in shaping and finishing the "wings." The printing press is used for printing the design on the cloth and also for printing advertising pamphlets and circulars. On this same floor a 3 horse-power motor drives a group of special sewing machines.

The entire plant is well equipped, roomy, and modern in every respect. While an excellent example of the methods in which single phase motors may be advantageously applied to the operation of textile mills, it also brings forward to central station managers the possibilities existing in territories reached by single phase distribution lines.

It is expected that the adoption of the electric drive will result in a maximum output with minimum operation and maintenance expenses, as has been proved in similar cases, to say nothing of the additional advantages of cleanliness and flexibility that go far toward making popular this method of machine drive.

Standard Symbols for Wiring Plans

The National Electric Contractors' Association of the United States and the American Institute of Architects have issued a chart of standard symbols showing various outlets, fixtures and other wiring devices. The General Electric Company, Schenectady, N. Y., has just issued a little booklet giving sample plans of an office or accounting room, and of a kitchen and dining room in which the symbols are illustrated. The other pages of the brochure are used to illustrate and describe many of the G. E. specialties indicated by the symbols in the plans.

The N. E. L. A Exhibition Committee

At the Washington Convention of the National Electric Light Association last June, the Class "D" members (manufacturers) of the Association made a most attractive exhibition of electrical apparatus and appliances. During the convention these exhibitors got together and offered to relieve the Association of the troubles and responsibilities connected with the organization and maintenance of such exhibits at the annual conventions.

The executive committee of the Association approved a plan whereby the Class "D" members were to recommend annually an "exhibition committee" or Class "D" or "E" members. This committee, upon recognition by the president, would elect its own chairman, and organize to conduct the work pertaining to manufacturers' exhibits at the convention.

A nominating committee was formally appointed consisting of

Mr. George F. Porter (chairman), Atlantic Insulated Wire Co., 120 Liberty St., New York, N. Y.
Mr. T. G. Whaling, Westinghouse Lamp Co.
Mr. Alex Henderson, American Circular Loom Co.

The ticket presented by this committee to the Class "D" members has been approved by a mail ballot of Class "D" members and accepted by Mr. Dudley Farrand, president of the N. E. L. A. This committee, known as the "exhibition committee," is as follows:

Mr. F. H. Gale, General Electric Co.
Mr. J. C. McQuiston, Westinghouse Co.
Mr. H. P. Heger, Allis-Chalmers Co.
Mr. Rodman Gilder, Crocker-Wheeler Co.
Mr. H. M. Post, Western Electric Co.
Mr. C. P. Frey, Weston Electrical Instrument Co.
Benj. Wall, Metropolitan Engineering Co.
Mr. James I. Ayer, The Simplex Electric Co.
Mr. S. E. Doane, National Electric Lamp Association.

On December 6th, the committee met in the Association Rooms in New York and elected Mr. F. H. Gale chairman.

A committee on by-laws and rules for governing the committee was appointed, and preliminary plans regarding the convention next June were discussed. The committee is, of course, subject to the executive committee of the Association and will co-operate fully with the president and other officers in making arrangements for the convention.

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The Central Station

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS

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NOTICE.

Advertisements, Changes in Advertisements, and Reading Matter intended for the next month's issue should reach this office not later than the twenty-fifth of this month.

No commissions are allowed on advertising contracts or subscriptions.

Entered at the New York Post Office as Second Class Mail Matter.

Circuit Breakers and Switches

The conditions of service in central stations are such that the greatest reliance is placed on switches and circuit-breaking devices placed in different parts of the system. Roughly speaking, they may be found the smaller switches used for controlling a few lights or more, the larger switches which govern groups of lights and the main switches which control everything. The requirements of service in connection with switches is of such a character that every competent engineer is more or less familiar with them. The idea that anything will do of a fairly good mechanical construction for breaking a circuit is rapidly losing ground. In high tension service, for instance, the insulators and the switches receive the greatest, if not the most detailed attention before being used as part of the equipment. The association of these two factors in electric light and central station service is not accidental. Switches for high tension service must be insulated, as well as be capable of breaking a circuit effectively and without danger to life or risk to the building. But the general conditions prevailing in central station service particularly are such that switches and circuit breakers govern, in a sense, the efficiency of the plant.

It would be unwise to believe that that which is called commercial efficiency or electrical efficiency has as much to do with the success of the equipment as that which we term efficiency in its broader sense. The so-called switch manufactured and sold in the open market is designed with reference to considerations of amount of current and degree of pressure, to which it will be subjected. In this respect the manufacturer and designer are given opportunities for displays of talent, but then their interest ends. On the other hand, the commercial man or jobber takes an interest in the article to a degree proportional to its selling qualities. It finally enters into the installation of which it forms a permanent part, and its real history begins, as was originally intended as part of an operating central station, or electric light equipment.

The conditions of practice are so varied and the opportunities for success or failure in this respect so pronounced that the history of a switch is really dependent upon the amount of solidity imparted to it by the manufacturer before it leaves his hands. In other words, aside from the question as to whether it will carry the current, without heating or without causing a drop in pressure of such value that its use is forbidden, arises consideration of its substantiality. In central station service it will be admitted by those familiar with its early history that the main difficulties there were not so much those of regulation and efficiency as those due to the temporary nature of the devices employed. When the conclusion was reached that electric lighting had become a fixed institution and that, in consequence of this, all of the devices employed must be made substantial and durable, a change took place, the effects of which can be readily noted to-day in looking over switches of all types, including circuit breakers.

A point might be raised by some experts as to the difference between a switch and a circuit breaker, but it is evident that the switch is a device which opens and closes a circuit at the will of the

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operator, whereas a circuit breaker is a switch which automatically opens the circuit only when the flood of current rises too high. On this basis it is not necessary to go into details concerning either one or the other, except in so far as they bear upon the general question involved, that of the influence of such devices upon the efficiency of central stations.

Each year sees additions made to the central stations in active service throughout the country. And each year sees a constant increase in the dimensions and capacity of such energy centers. In consequence of this, the design of switches and circuit breakers was necessarily taken out of the hands of experimenters, laymen and incompetent electricians, and turned over to specialists whose devotion to this particular branch of the electrical industry has been the means of giving rise to designs which are regarded as par excellence in practical engineering. Certainty of operation in the case of circuit breakers means the absolute protection afforded by a device against the destruction of valuable machinery. In both central station and street railway service, one of the most vital parts of the equipment is unquestionably the circuit breaker.

A large, well made, correctly designed, easy acting switch is the first of the requirements attending the design of a circuit breaker. Even though other than metallic contacts finally break the circuit, it is evident that it is inherently a switch and as such must be proportioned along the line which this particular type of design demands. The other phase of its operation, namely, the automatic action which it is to perform, is merely coincident with the original idea presented. The automatic action, therefore, which is in all cases dependent upon an electro-magnet, whose action is balanced against a spring, is more a question of mechanics than electrical design. But the parallel purposes must be combined in this device to a degree approaching perfection, if it is to prove efficacious when the demand is made upon it by the severe requirements of service.

The advantage of switches strictly reliable in operation can be best appreciated by those whose experience dates back one or two decades. The wooden base has been eliminated. The questionable make and break exists no more. The contacts or surfaces which met and through lack of sufficient contact developed heat and resistance are almost forgotten. Even the smallest of switches are protections against shock and fire and represent an excellence of design which is more than noteworthy considering the difficulties presented in the small space their parts occupy. It might be natural, therefore, to expect in the larger switches and the great circuit breakers found in power houses and central stations, an excellence of workmanship and planning which leaves little to be desired. A rather well kown professor of mechanical engineering laid down this proposition with regard to automatic devices which can be taken to heart by all interested in that class of work. He said, if an automatic device requires watching by a man, throw out the device and keep the man. This moral is obvious in the case of electrical devices designed with the idea of securing automatic action. The circuit breaker is made to be automatic and no risk whatsoever can be taken in its design or operation which in any way mitigates against this result. If circuit breakers stick when a crisis occurs, fuses would be expected to blow and there are many instances that might be cited where their blowing would mean direct loss of life and limb, as well as destruction of property. It is not a bad idea to occasionally consider the dangers lying latent which may rapidly be brought to life by the use of poor switches and inoperative circuit breakers. Fortunately, the American products are not only strictly to-to-date, but unexcelled in design and operation. For this reason, the products of reliable manufacturers will not only be accepted, but meet, as past records have shown, with a rapidly growing market.

Copper and Power Transmission

Power transmission has become one of the greatest fields of electrical engineering practice. Among the fundamental questions arising in this particular department of high tension alternating current exploitation are insulation and copper. The weight of copper is important because it means capital and labor. The insulation is obviously important because it not only means capital invested, but distance over which the power can be transmitted The entire proposition, therefore, is knitted together by considerations governing the capital invested and the distance of economical transmission.

In a table prepared by Rhodes, of England, a contrast is made between the pounds of copper required for direct current and alternating for the following purpose: Comparison of the amounts of copper required for line wires for transmission of the same amount of power at the same line voltage over equal distances at the same efficiency. In this table it is shown that 1,000 pounds of copper

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for direct current transmission are cut down to 750 pounds for three-phase, mesh and star systems. A two-phase, three-wire system is represented as requiring even less than 750 pounds in comparison. The facts which have been collected bearing upon the subject show the tendency to increase over what has been so far accepted to a still higher pressure in power transmission.

Systems have arisen in the West in which pressures extraordinarily high are employed with safety and economy. In fact, any discussion of the copper question is really one pertaining directly to the pressure question. Therefore, it is evident that all marked increases in the pressuure employed means proportionately marked decreases in the amount of copper necessary. The two horns of the dilemma which presented themselves were first, the difficulty of securing adequate and reliable insulating devices, and secondly, the system for transmission which would prove to be the best. Experimenting in this respect has been carried on in a manner which involves large amounts of capital. The first alternating current transmission plant of any importance was the 5,000-volt system installed at Niagara, and connecting with Buffalo. This three-phase system was the source from which inspiration was drawn which led to the crystallization of other schemes in various parts of the country. There is no settled information bearing directly upon the subject of pressure to which authoritative reference could be made at present. The data at hand is naturally derived from the plants at present in operation, and in consequence the new ones still to be designed and built will be modeled on lines partaking of the nature of the old.

Though power transmission has settled down to what might be called a distinct engineering problem both as regards pressure, insulation and weight of copper, it must be admitted that other questions arise which clearly indicate anything but a settled state of mind on the subject. Authorities differ in many instances as to the character of the system to install. They differ with regard to the pressure to be employed over distances exceeding fifty or seventy-five miles. They have opinions at variance with each other as to the character of insulators best suited to the purpose in view. And they now differ in some instances to a marked degree as to the character of the current best suited to the ends desired; whether single-phase, two-phase, or three-phase is most desirable.

It must be admitted that the difficulties confronting experts have been largely swept away as evidenced by the practice of the hour. The employment of 60,000, 80,000, and even 100,000 volts shows no lack of courage in attacking the problem with the materials at hand. But other problems of gigantic proportions loom up occasionally in the public eye, and show the necessity for decision as to that which must be construed as the best practice in all such cases. The carting of coal from the mines to great cities must, in the course of time, be replaced by a system involving the transmission of the power of the coal instead to the great cities in the proximity of the mines. In fact, without intending to prophesy, it seems evident that power transmission cannot and will not be limited to the mere conductance of power where natural sources like water-falls are available to points finding the use of such power convenient. The extension of the idea of other localities will follow as a matter of course. Even to the extent of harnessing the power found in coal where nature has produced it and sending it on its mission in the shape of electrical energy. Unfortunately, the future of coal is not what our domestic economists anticipate, and it may be that investors occupied with the question of the smoke nuisance and the complete consumption of not only coal, but its ash as well will find the use of coal a rarity. In its place energy will be poured into New York from large central stations situated at the very site and source of the fuel from which they derive their energy.

Fuses

The protection of circuits by means of fuses has been reduced to a science, due to the fact that the fuses themselves have been made reliable. So far the difficulty has been due to variations in the quality of the fusible metals employed, and differences of temperature in different parts of buildings whose wiring was protected by them.

A good fuse is one which will melt when a certain current passes through it. In contra-distinction, a bad fuse is one which will melt unexpectedly. The use of reliable alloys drawn to diameters calculated by experts, and copper wire, has done away with considerable doubt formerly existing as to whether fuses were to be depended upon or not. A new form of fuse is made of aluminum wire, and each type of fuse wire performs a distinct service in a field for which it is particularly suited. For instance, it is recommended that lead wires be used for currents of ten amperes or less, the copper and aluminum wires be used for ten amperes or more.

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The gage sizes employed in the case of aluminum and copper wires will probably be interesting to the reader, and are given as follows: No. 24, B. & S. for copper, and No. 23 B. & S. for aluminum, where the current is from ten to fifteen amperes. No. 23 B. & S. for copper, and No. 22 B. & S. for aluminum where the current is from fifteen to twenty amperes. Other figures might be given, but they would only tend to show how aluminum wire, in comparison with copper wire, is of a larger size. As, for instance, where No. 21 is used for a copper fuse, No. 20 for an aluminum fuse where the current is from twenty-five to thirty amperes. There is this to be said at least, as far as alloys are concerned: If the metals composing them are mixed correctly and the wire made therefrom drawn of uniform mdiameter, tests would easily indicate the exact point of fusion. It must be admitted that a more substantial metal, like copper or aluminum, would meet with approval, not only on account of its reliability, but its strength as well. In handling fuse metals, soft metals are apt to break under the screw when it is tightened down. A more resisting metal, in a mechanical sense, is for this reason, apt to be more acceptable, but the choice of a lead alloy, or a copper or aluminum wire, is largely a matter of experience and custom, the balance of favor being on the side of the latter.

MONTHLY REVIEW OF THE TECHNICAL PRESS

Dangers Incidental to Coal Storage in Central Stations

It is an increasing practice in our larger electricity generating stations, in view of the highly efficient steam-raising plan now available, to utilize large quantities of small and dirty coal on the perfectly correct hypothesis that it pays better to burn a somewhat larger amount of poor and dirty coal than to buy the best coal of a high calorific value at an enhanced price. When one reads, however, of the disastrous explosions in coal mines from coal dust, a serious doubt arises in one's mind as to whether we are taking sufficient precaution in the storage of large quantities of small and dirty coal in the bunkers of our power stations, more especially as such bunkers are not very largely sub-divided, and trouble occurring in any particular part of the coal may easily extend to the whole storage of the fuel. The practice of storing coal over the boiler room in a long, low, and often not to well ventilated bunker, is quite a common thing. The coal which is generally in the form of peas or nutty slack, falls from a conveyor into pen bunkers or direct into the hopper slits, and the air at times is so dense with coal dust that there is no doubt that a match carelessly struck in the midst of this dust would cause a similar explosion to that which from time to time occurs underground, quite apart from the danger of spontaneous ignition.

Cases of fires in bunkers are by no means rare, and are commonly caused either by spontaneous combustion or by heat, owing to the fact that the coal is being stored against hot boiler or flue walls. If a large quantity of coal is bunkered in wet weather and shot on to a heap or into a narrow, deep bunker, it will, if in the form of small slack or peas, be almost sure to heat, and should, if likely to be unused for any length of time, be probed with a stick every day to see whether it is heating or not.

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A case occurred some years ago in a large power station where some thousands of tons of coal were destroyed in this manner. The coal was shot when wet into four square deep 250-ton pen bunkers, the floor of which was always hot from being immediately over the boilers. The inevitable result followed, and as the coal when found was well alight in the center and bottom of each bunker, it was impossible to take it out, as it broke into flame immediately the air got at it. The only thing to do was to continuously soak the heaps with a water hose, and for five weeks this coal smouldered until it was entirely coked and spoiled. When it was finally cleared out the iron floors of the bunkers were found to be badly burned at the bottom, and the back end of the bunker room was seriously cracked and bulged.

Another case occurred where a few tons of coal were tipped against the side of a water tube boiler, which was at the same under steam, in a direct-current station which shut down at midnight. At 7 A. M. the boiler-house roof was seen to be on fire; the heat from the boiler had fired the coal. The fire had traveled through a heap of about 10 feet in the few hours intervening, and set fire to the temporary end of the boiler-house, which consisted of wood and galvanized iron.

It will be seen from the above notes that the class of coal so commonly used nowadays with mechanical stokers is undoubtedly a source of danger in storage, and much greater care should be exercised in bunkering these coals than is needed with the larger varieties.

The Human Side of the Engineering Profession

By Professor V. Karapetoff.

There are three essential requisites for an efficient and successful engineer:

Sound professional knowledge;

Knowledge of business forms and of human relations;

Good and strong character.

A man who knows only "how" to do certain things, but does not know "why" they are done so, usually remains in subordinate positions. Get into the habit of analyzing; also, have your knowledge systematized.

In order not to get "rusty," you ought to do some study, or at least some reading outside of your daily routine work. This outside work may be classified, in an ascending scale of difficulty, as follows:

Keep notes on your regular work, with sketches, samples of calculations, etc. On separate notes keep matters of doubt to straighten them out at a future opportunity.

Read regularly at least one periodical relating to your specialty, and keep some kind of a general index on at least one subject in which you are particularly interested.

Be sure about the fundamental laws, facts, and assumptions on which your branch of engineering is based. If you are but recently from college, you can go over your old books and notes; otherwise read a good modern text book.

Gradually get familiar with more advanced books, treating of the various branches of your profession; go from time to time to the public library and see if there is anything new in your specialty.

Select some one branch of engineering, if possible somewhat different from that in which you are regularly engaged, and devote some time to it. Know more than the next fellow does; it will pay you.

Do not miss any chance to make an original investigation; this will develop your thinking, increase your self-confidence and raise your standing in the profession.

Inventing is the highest form of the engineering activity; there is no reason why you should not bring some improvement into the work in which you are engaged. Concentrate your mind on one thing, work patiently and persistently, and you will be sure to achieve something that will be new and useful.

You naturally expect some day to occupy a responsible position in your profession. This is impossible without a sound knowledge of established business forms and of human relations in general. Here, again, there are several stages of study and observation. Take up as many of them as your ambition, time, and ability will allow.

Observe the characters of men you are working with; in particular, the influence of their previous experience and education, of their age and temperament, of their views on general life questions, etc.

Observe things that make them efficient and happy, or that are impediments in their work;

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things that they would like to have and the main things that they object to.

Observe critically your superiors and their ways of acting towards their chiefs and subordinates. Do this without malice, but rather with a sincere desire to find out the best way of conducting the work, when you shall be called to perform their duties. Make for yourself a clear mental picture of an ideal man in a certain position, and try to follow this ideal in your own business life.

Observe and read about general business systems adopted in large modern commercial and industrial enterprises; in particular,

Subdivision of the duties of various officers, and their correlation;

Correspondence, accounting, orders, receipts, etc.;

Causes of loss, waste, inefficiency, etc., and possible remedies.

MMerely knowing the facts is not sufficient; you must see clearly the necessity for a certain organization. Only then will you find a right place in it for yourself and efficiently discharge your duties.

Do not get "rusty" on general life questions; read books on history, economics, philosophy, etc., with the view of finding the underlying facts and motives in human relations. Do not adhere too readily to a traditional school; work out your principles for yourself, and be willing to change them when new evidence is laid before you. A man in a responsible position must be a well educated man; he meets a great many men, and has to face new situations. Therefore he must be well informed on things in general, and ought to be able to judge about them.

Engineering and business knowledge are the necessary conditions for usefulness ("success" and usefulness are not always the same), but the proper development of the character is the third necessary condition.

What is the use of having a profound knowledge of engineering, if you have not the necessary perseverance to achieve results; or to have a knowledge of business forms and relations, if your temper is such that nobody cares to be associated with you in business?

Practice daily the qualities of the character that you find essential for a good citizen and a good business man.

Work patiently on any problem until a result is achieved. If it should be impossible to get satisfactory results, at least make clear to yourself the nature of the hindrances.

Be honest in all things; do not be afraid to confess your mistakes or your ignorance. Train your character by doing your work over cheerfully.

Keep down your selfish personality and ambition. Do not let them interfere with your business. *The highest goal of personality and ambition is to have your part of the work done in the most ideal way.*

Be generous, polite and considerate to others; there are no circumstances where you would be justified in breaking this rule. Remain dignified even under unjust reproof.

Work with the understanding that your activity of to-day shapes your future. You need not trust to chance; *your opportunity will come when you are ready for it.*

Some men are happy and efficient in their work without having any clearly defined conceptions of life and its purpose. In a great majority of cases, however, a lack of a workable theory of life brings with it a decrease in possible efficiency and in personal satisfaction. It is of importance, therefore, to know.

What are the principal limitations and wrong beliefs that are hampering engineers in their work.

How these limitations can be removed by working out a theory of life that gives a general meaning to man's activity.

How an engineer's work is shaped, when his underlying motives are illumined by such a theory of life.

Usual limitations that prevent an engineer from being fully efficient and happy in his work.

Belief that he is underpaid; abnormal striving after money.

Belief that his efforts are not appreciated by his employer; also that there is no chance for promotion.

Lack of knowledge, theoretical or practical; lack of general education; a deficient knowledge of business forms and human relations. This is often accompanied by a belief that he has no time for study; in cases where a man has not exercised his mind for a long time, he has also to contend with his own mental apathy.

Deficiencies in character, such as weakness, roughness, egotism, narrowness, pedantry, absent-mindedness, laziness, etc.

Lack of enthusiasm due to the absence of a guiding and unifying purpose in life. This is particularly noticeable in very young men who are just beginning to form their own conceptions of life, and in older men who already see the end of their usefulness and cherish no more illusions.

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Each man must work out for himself a practicable theory of life; this will make his acts and words, thoughts and feelings, harmonious and consistent. The experience of humanity past and present is the material to work on; his reason is called upon to interpret this, and his conscience is the court of final appeal.

The following is *an example* of such a theory of life:

The Universe, including man, is governed by an Infinite Intelligence, which is manifested in man as his conscious life. There is no meaning in a man's life if it be detached from other men's lives. In proportion as he becomes conscious of this one, infinite life, common to all men, his own life becomes reasonable and harmonious, and the fear of poverty, sickness, old age, and death gradually disappears.

The highest purpose of life is to work for the realization of the above ideal conditions of life on earth. We do this either by actually removing certain hindrances and fetters (practical work), or by making this great work clearer to others (literary, educational work, preaching, etc.).

Once this attitude is understood, the real compensation for the work consists, not in money and notoriety, but in the state of consciousness reached. This is manifested in particular:

In a clear and definite program of life, and a ready answer for all difficulties (doing your best).

In a state of harmony and good fellowship with all men, through the understanding of that life which is common to all.

In a freedom from fear, anger, jealousy, apathy, and other limitations caused by the assumption that life is an accidental chain of phenomena and circumstances.

Once he has obtained a workable life-theory, all of the limitations enumerated above, that prevent an engineer from being efficient and satisfied in his work, can be removed by actually applying this theory to his daily work.

The belief that he is underpaid or not appreciated enough loses its power; the man works no more for a company or a corporation. He works for his conscience's sake, and finds his true compensation in the results of his work.

He is full of desire to do as much as he can, and not as little as he is allowed to. For this reason he wants to know much and to have his knowledge in a practical form, ready for use. He is active and studious all the time, and the expression "mental lethargy" is incomprehensible to him.

He frees himself from possible shortcomings in his character by keeping the ideal of perfection continually before his mind's eye. He no longer finds difficulty in handling men and in treating his coworkers and chiefs aright; he has a sincere sympathy for them, tries to help them, and to make their work more pleasant and efficient.

He is full of enthusiasm, for he is aware of the infinite importance of his life and work. His work is infinite as is Life itself; and each problem solved brings with it a higher and more important problem, brings more truth and light into his consciousness.

Make yourself ready for a broader and higher field of activity; then your opportunity will surely come.

The true purpose and value of engineering activity lie in providing better and easier ways for satisfying ordinary human needs. This provides more leisure and opens new possibilities for a higher spiritual and intellectual development of humanity.

The engineer's personal satisfaction consists in knowing this high purpose of his vocation, and in giving his service at a maximum efficiency. The other compensation is a result and not the purpose. —Read before the New York Electrical Society.

Those central stations which now own and operate electric or gasoline automobiles, lamp delivery wagons and runabouts in connection with the business of their stations, and which have had trouble with punctures and blow-outs in their pneumatic tires, will be interested to know that these tire troubles can now be entirely eliminated. The Elastic Tire Filling Agency, of 52 Church street, Boston, Mass., is equipped with a most ingenious plant for the filling of new or practically worn-out pneumatic tires with their elastic filler, which is the nearest approach, in resiliency, to air which has yet been attained. Their customers send to them their tires on their wheels in a crate by freight or express, and this new elastic filler is forced by air pressure into the tire, completely filling same, and after a baking process the filler gives the tire practically the same resiliency as if it were filled with air, at the same time making it absolutely impossible to puncture or to blow out; and the most expert drivers can hardly detect any difference in the riding qualities over tires filled with air.

This new process is certainly a boon to commercial and pleasure vehicles of every description originally equipped with pneumatic tires. Write to the above company for further particulars and testimonials.

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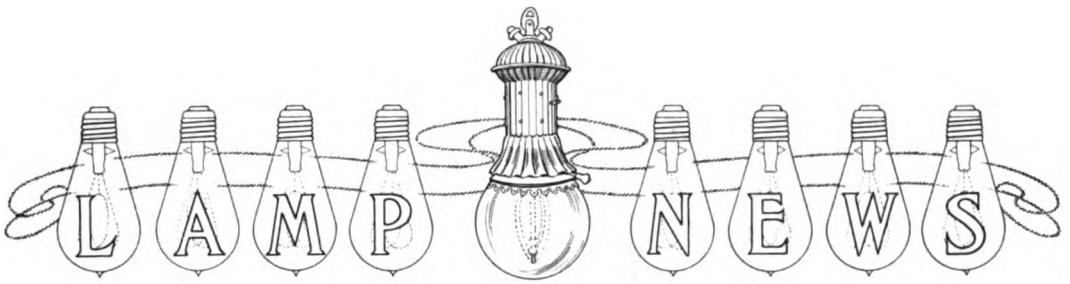
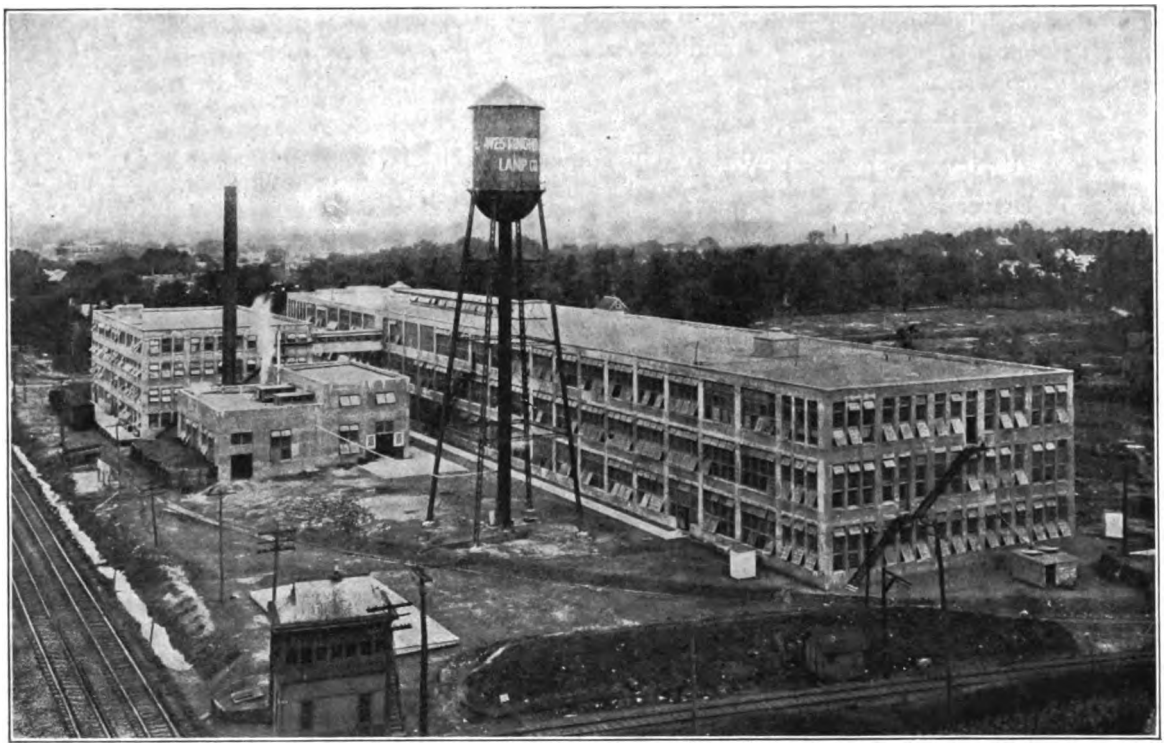


The Westinghouse Lamp Co. has just completed its large new factory at Watsessing, N. J., on the Montclair branch of the D., L. & W. R. R., and about twenty minutes' ride on the train from the West 23rd street ferry in New York City. The location is a most accessible one for employees, being located almost at the foot of the Orange Mountains, and is most healthful.



THE NEW FACTORY OF THE WESTINGHOUSE LAMP COMPANY AT WATSESSING, N. J.
CAPACITY, 45,000 INCANDESCENT LAMPS PER DAY.

This new plant, as will be seen by the accompanying illustration, consists of these buildings; the main factory, the warehouse and the power house. The main building, which is the largest building ever constructed originally for a lamp factory, is one hundred feet in width, and five hundred feet in length, three stories high and built of reinforced concrete throughout, making it practically fireproof construction. Each story is seventeen feet in height and the windows extend to the ceilings on each floor, and are so constructed that any degree of ventilation or light may be obtained throughout. The first floor contains the carpenter shop, the machine shop, filament plant and furnace room. The second and third floors are occupied throughout by the latest improved lamp making machinery, where every detail in the construction of their lamps follows through its regular course in the factory, and the perfect article is then ready to be sent across the bridge which connects the main factory to the stock rooms in the warehouse.

This new plant will give employment to one thou-

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sand operatives, and its capacity is forty-five thousand incandescent lamps per day, and will have an annual output of 9,000,000 lamps.

The present plant of the Westinghouse Lamp Co. is situated, as it has been for years, at 510 to 534 West 23rd street, New York, occupying nearly half a city block. The output of the New York factory is 6,000,000 lamps annually. The present capacity. therefore, of both the plants is 15,000,000 lamps per year.

The Westinghouse Lamp Co. at present has branch offices at Atlanta, Baltimore, Birmingham, Boston, Buffalo, Butte, Salt Lake City, Charlotte, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Denver, Detroit, Hazleton, Pa., Joplin, Kansas City, Seattle, Los Angeles, Louisville, Milwaukee, Minneapolis, New Orleans, Syracuse, New York, Philadelphia, Pittsburg, Richmond, St. Louis and Tucson. Its branch in Canada is the Canadian Westinghouse Co., Ltd., of Hamilton, Ont., and its business in Mexico is looked after by G. & O. Braniff & Co., City of Mexico, a new lamp company.

A New Lamp Company

Mr. E. F. Dwyer is the president of a new lamp company now equipping a factory in Lynn, Mass., to be known as The Lynn-Dwyer Lamp Company, which will manufacture a special form of metallic filament lamp, and this same style of filament will be used for the refilling of burned-out lamps. President Dwyer states that these new lamps will be made in all standard sizes from sixteen candle-power up.

The Daniels Boulevard Lighting System

A well known architect has recently made the statement that electric lighting has been in existence thirty years, electrical illumination five years, and artistic lighting three years. This may seem to members of the electrical profession a rather sweeping statement, yet in the broadest sense it is true. As we make a rapid survey of electric lighting, we are forced to agree with the architect and we are thoroughly impressed with the present rapid strides toward the production of lighting specialties embodying artistic, as well as utilitarian qualities. Fixture designers, illuminating engineers and manufacturers have been particularly active in designing artistic indoor fixtures, candelabra, shades, etc., but have for some reason overlooked the design of specialties applicable to improved outdoor lighting.

The importance of artistic designs for outdoor illumination was early appreciated by Mr. W. E. Daniels, of the South Park Commission, Chicago, Ill., the result of this study being the invention and patent of the Daniels System of Boulevard Lighting. The manufacture and exploitation of this system has been undertaken by the Jandus Electric Company, of Cleveland, O., and a short description may prove interesting to the readers of THE CENTRAL STATION.

As shown by the accompanying figure, each unit consists of a rectangular base, reinforced concrete

column, covered by an Ionic capital and the whole surmounted by a twenty degree opal ball globe, enclosing a complete arc lamp mechanism. Exhaustive experiments were made to determine the relative values of steel and concrete posts for this particular kind of service, the result of which has been the selection of concrete, some advantages being its susceptibility to any natural stone or marble finish, ranging in color from deep gray to pure white, its indestructibility, the fact that it is more attractive than painted steel goose neck designs. the post will not oxidize, will not require painting and the cost is much below any steel construction heretofore introduced. A few of the possible applications of this system are the lighting of business blocks, public buildings, capital grounds, pub-

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lic squares, boulevards and parks. The system at the present time is applicable to either Multiple Direct Current or Series Alternating Current circuits, the Multiple Direct Current being usually furnished in business districts and the Alternating Current distribution for outlying residence sections, parks and boulevards.

In producing the above fixture, it has been the endeavor of the inventor and the manufacturers to furnish an article, every part of which should be in harmony with every other part and the fixture as a whole to be in perfect accord with the most artistic environments.

A New English Arc Lamp

The accompanying illustration shows the external appearance and the mechanism of the "Victor" enclosed D. C. arc lamps, which are being introduced by the Electric & Ordinance Accessories Company, Limited, of Stellite Works, Aston, Birmingham, England. These lamps have been standardized in three forms—the "Standard," "Miniature" and "Flame" lamps, and have been designed with a view to securing the utmost simplicity of construction interchangeability of parts, and excellence of workmanship and material.

The mechanism contains no clockwork, shunt coils, or dash-pots, and there is only one moving part. The "Standard" lamp burns for 100 to 140 hours without retrimming, and is easily trimmed and cleaned. The insulation is suitable for high-voltage circuits, and the voltage across the arc, it is claimed, is unusually high, giving a high efficiency.

The one moving part is contained inside a sealed tube, and the arrangement of the parts is practically symmetrical round a central tube. The coils are impregnated so as to be impervious to moisture, and there is no regulating mechanism. The lamp is suitable for burning either singly, on circuits up to 125 volts, or in series with others of the same make, and the "Standard" type is stocked in only one size, taking five amperes. The line resistance, which consists of Eureka wire wound on a glazed porcelain cylinder, is contained within the case; the coil is self-contained, and is connected with the clutch by a copper flexible, but the grip is of steatite, and therefore carries no current, so that it cannot be injured by sparking. The upper part of the case slides down over the lower part when it is desired to inspect the interior, and the whole of the case is insulated from the circuit.

The globe is of special design, only the lower two-thirds being opalescent, and the upper third clear glass; thus the upward light from the arc has an uninterrupted path to the globe support and reflector, which are white enameled, giving the maximum efficiency of illumination. Air ducts are provided in the base, round the case, and under the crown of the lamp, giving ample ventilation. The carbons are both of the same diameter, and

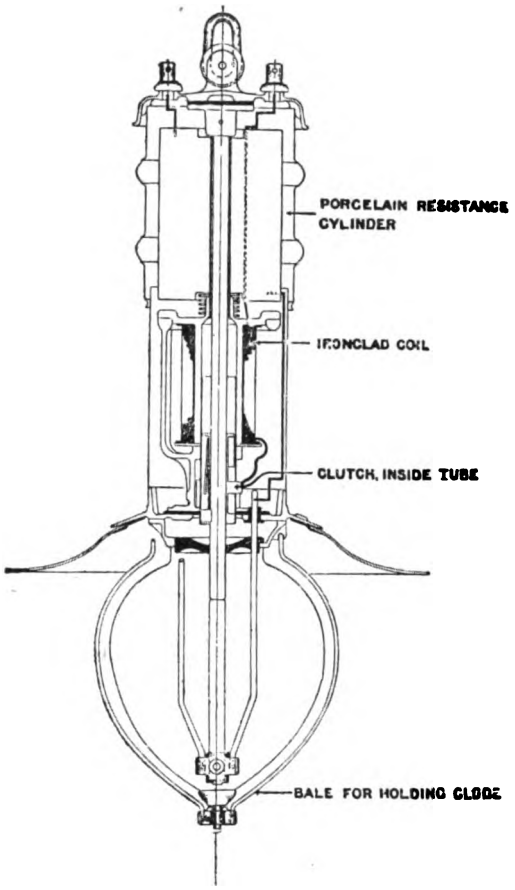

FIG. 1.—MECHANISM OF STANDARD LAMP.

the stump of the upper carbon is just long enough to be used for the negative when trimming.

Fig. 1 shows a section of the "Standard" lamp.

Solar Glass Company, of 319 Superior street, Toledo, Ohio, is the name of a new company recently formed to manufacture incandescent and arc lamps. This new company claims to have a new and secret process for the treatment of the filaments used in the Solar incandescent lamps, which adds greatly to the economy, efficiency and brilliancy of the lamp. The president of this new company is Mr. George E. Dutton, and the general manager, Mr. E. J. McMullin, both well-known and prominent business men in Toledo.

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The Engineering Department of the National Electric Lamp Association, of Cleveland, O., received such demands for its bulletin No. 7, issued June 1, 1907, that it was compelled to get out a second edition.

This bulletin contains most valuable data on illumination, and was compiled especially for the use of electrical engineers, illuminating engineers, and electric lighting stations. It describes various methods of illumination, a treatise on the measurements of light, and as many valuable tables of the greatest interest to the field of illumination and illuminants.

The tables on incandescant lamps, showing the amount of current taken by lamps of various candle powers, efficiencies and voltages, as well as the tables showing the sizes of wire to be used for various conditions, are especially valuable.

This bulletin will be mailed to any Central Station manager upon request.

The Columbia Incandescent Lamp Company, of St. Louis, Mo., has recently opened a New England branch office at 280 Devonshire street, Boston, Mass., where a complete line of Columbia lamps is now carried in stock, for the benefit of their rapidly increasing New England business. The above company has smaller offices in New York, Philadelphia, Chicago, and Memphis.

The General Incandescent Lamp Company will light the M. B. Austin & Company's booth at the Chicago Electrical Show. All kinds of incandescent illuminants will be used, including High Efficiency Gem Lamps, Tantalum and Tungsten. It is expected that Mr. H. C. Rice, vice-president of the General Incandescent Lamp Company, will be present personally during most of the show to answer questions and explain these new devices to all interested. Bring your girl around and get a souvenir stick pin, also one of the G. I. "Quality" calendars. They are very pertty and, best of all, they are free.

Bryan-Marsh Company have recently completely equipped the Hotel Jefferson, of St. Louis, with Bryan-Marsh Tantalum Lamps, which are giving perfect satisfaction in every way. The above company has sold this hotel twenty-eight hundred Bryan-Marsh Tantalum lamps, which is one of the largest installations of this kind in the world.

The Re-New Lamp Co., of Boston, Mass., has, during the past year, added considerably to its plant, process and machinery, and now claims to have an ideal plant for the renewing of incandescent lamps. Its product has been greatly benefited by this extensive new outfit. The company reports a very large increase in business over previous years.

The growing popularity of good refilled lamps is well evidenced by the fact that the Standard Electric Lamp Co., of Newark, N. J., after only six months under its present management, is compelled by its rapidly increasing business to seek larger quarters. Notwithstanding the difficulty of moving at this busy season they have fitted up a new factory with three times their present capacity, at 67 Hamilton street, Newark, N. J., and will occupy it January 1. The officers of this rapidly growing company are: Charles C. Curry, president; William Ropes, treasurer, and M. H. Welsh, superintendent.

There is no subject, with the possible exception of the coal pile, which is of more vital importance to central stations than the lamp—both incandescent and arc—and to concentrate all news items and articles on this important subject, the new department "Lamp News," commences in this issue of THE CENTRAL STATION.

This new department is to be considered as a bulletin board for the use of manufacturers and others for bringing to the attention of central stations any new illuminant, or improvements, modifications or changes in already established standards.

This department is also at the disposal of central stations for the publication of communications, criticisms, and questions and answers pertaining to the subject of incandescent or arc lamps and illumination.

Every article or item published under this heading is a "communication" and the contributor is responsible for the statements or facts which appear.

No charge has ever been made, or ever will be made, for the publication of any article or item in the reading columns of THE CENTRAL STATION, nor is any contributor to consider himself under the slightest obligation by having his news item or article thus published.

The right, however, is reserved to reject, rewrite, or abstract, without altering the facts, any communications which, in the opinion of the publisher, is for the best interests of central stations, to which THE CENTRAL STATION is devoted.

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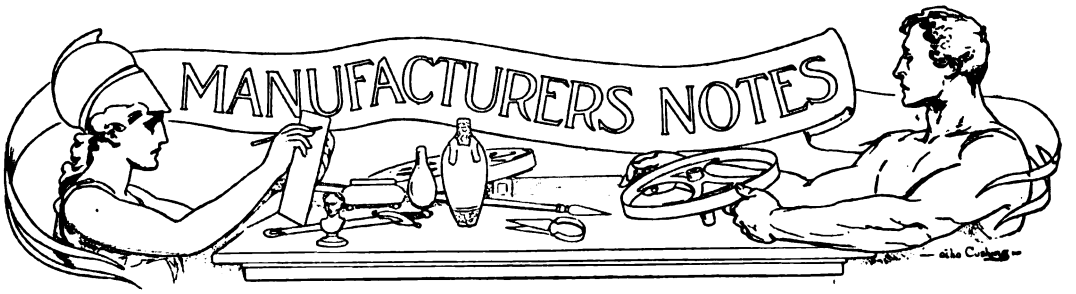

Belted Alternators

While direct-connected alternators have largely displaced belted machines in modern power stations, there are many places, particularly in comparatively small installations, where belted units are desired. Belted machines are easily connected to an existing source of power, as, for example, a line shaft used for driving other machinery, and for comparatively small installations they are lower in first cost than direct-connected machines.

Allis-Chalmers alternators, which may be regarded as standard, are of the revolving field type, the belted machines being provided with a substantial cast iron base to which the bearing pedestals are bolted. The larger machines have the stator arranged for shifting sideways along the base to give access to the field and armature coils.

The coils in which the alternating electromotive force is induced by the revolving field, are placed in slots in the inner periphery of the armature core which is external to the field and supported by a substantial cast-iron yoke. In order to secure good ventilation, the yoke is provided with numerous cored openings through which air currents set up by the revolving field can pass freely, thus carrying off the heat from all parts. The yokes are provided with shields which protect the armature coils where they project beyond the core; these winding shields offer very little obstruction to the air currents and add to the appearance of the machine.

The sheet steel used in the armature core is carefully selected with reference to its magnetic qualities, and care is taken to secure perfect punchings which, when assembled, will require no filing in the slots—a process that always increases the core loss due to eddy currents.

All stator punchings are annealed in furnaces specially constructed for the purpose, and before being assembled are coated with japan to prevent eddy currents. In assembling the core, spacing segments are placed at intervals to form ducts through which air is forced by the revolving field. The heat is thus carried away from the internal parts of the core and the temperature rise corresponding reduced.

Ample space is allowed in the slots for thorough insulation; each coil or winding unit is completely insulated before being placed on the core, and no insulation is placed in the slot itself. After the coils have been covered with insulating materials and treated with insulating compound, the parts that lie in the slots are pressed to exact size in steam-heated moulds. This runs the insulating material into all the small spaces in the coil, effectively excludes moisture and makes the whole insulation firm and solid. The ends of the coils where they project beyond the slots are heavily taped, and the connections between coils are made in a neat and workmanlike manner.

The armature terminals are led to a marble terminal board on which the terminals are so mounted and protected that it is impossible for an attendant to make accidental contact with them.

The rotating part or field is of very substantial construction and easily capable of withstanding all strains to which it may be subjected even at speeds much in excess of normal. In the smallest belt-driven machines the field spider takes the form of a hub built up of steel punchings which, when assembled, provide dove-tail grooves for holding the pole pieces. In larger machines the spider is usually a steel casting with dove-tail grooves milled in the rim.

The field poles are laminated, being built up of steel punchings held between malleable iron and

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plates. The poles are attached to the rotor by dovetail projections that fit into slots in the spider rim; steel tapered keys are driven in alongside the dovetails and the pole pieces cannot become loose.

All field coils, except on a few of the smallest machines, are of edgewise wound copper strip. This style of coil is essential for revolving field alternators where the pressure on the insulation, due to centrifugal force, is so great that cotton insulation on round wire will not stand. With a coil of copper strip wound on edge, the pressure is distributed over a large flat surface and the insulating material is tough paper that can easily stand the pressure. After the paper insulation has been placed between the turns of the coil and fixed in place with insulating varnish, the whole coil is clamped between plates and baked, thus cementing the turns together and making the coil form a solid mass. This type of coil is very substantial and it has another very important advantage, in that the heat from the inner parts can pass directly to the rapidly moving surface without meeting any obstruction in the shape of insulating material, as is the case in a wire-wound coil; these fields therefore run without undue rise of temperature in any part. The voltage between adjacent layers of the winding is very low and there is practically no danger of insulation breakdowns. On some of the smallest alternators the fields are wound with wire having a square cross-section.

Exciting current is supplied to the field coils through two collector rings mounted on the shaft. All collector rings on our alternators are of cast copper, which we have found more satisfactory than cast iron; the wearing qualities are excellent, and the contact resistance between brushes and rings is lower than with cast iron. The construction is so simple and substantial that the rings require very little attention.

Current is led into the rings by means of carbon brushes, the number being such that the current density at the rubbing contact is kept within conservative limits. At least two brushes per ring are always provided, so that one can be removed for inspection without interrupting the exciting current. The brush holders are simple and substantial; the tension spring maintains an even pressure throughout the life of the brush, and flexible copper shunts or "pig tails" are attached to the brushes to prevent current from passing through the springs.

The bearings on all belted alternators of this construction are of the ring oiling type with oil reservoirs of ample size; on machines over 125 K. W. the bearings have spherical seats and are self-aligning. Bearings are of ample size and lined with the best quality of babbitt metal; if properly cared for they will run cool under all conditions of load. The bearing pedestals are bolted to a substantial cast iron base that insures accurate alignment.

The efficiency of these alternators is high, not only at full load, but at underloads and overloads as well. On account of the care taken in the selection of the armature iron and in buildling up the core, the core loss is kept down to a minimum. The copper on both armature and field is of liberal cross-section, thus limiting the copper loss. In accordance with the recommendations of the American Institute of Electrical Engineers, the efficiencies of belted machines include windage and friction.

By regulation is meant the percentage rise in voltage when full load is thrown off, field excitation and speed being held constant; the percentage is referred to normal full load voltage. An alternator with poor regulation will show large variations in voltage with changes in load, the pressure falling whenever a load is on and rising when it is thrown off. These changes will be especially pronounced if the load is inductive, as for example, a load of induction motors. A badly designed alternator might show very fair regulation on non-inductive load and yet be unable to give full voltage on inductive load.

In the design of these alternators, special attention has been paid to regulation, and in all cases full voltage can be maintained on loads of low power factor. The stator diameter are liberal, thus allowing a large pole pitch (distance between centers of poles) and reducing magnetic leakage between poles. The armature slots and windings are designed to secure low inductance, and the magnetizing effect of the field is large as compared with the armature. There is a liberal margin in field excitation to take care of overloads or for operation on loads of low power factor; the regulating qualities are, therefore, as good as can be obtained without making the machines unnecessarily large and expensive.

B. S. Barnard & Co., which have been established for years at 39 Cortlandt street, New York City, in the manufacture and sale of vitrified underground clay conduits, have just established western offices

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in the Monadnock Building, Chicago. This company has also recently completed a new conduit factory near Chicago which, with their two other large factories in Pennsylvania, is now in a position to handle promptly their rapidly increasing orders for underground conduits. The combined annual capacity of the three factories of B. S. Barnard & Company is 15,000,000 duct feet in both single and multiple duct styles.

Capt. B. S. Barnard, the president of the above company, is also the president of the Standard Vitrified Conduit Co., of New York City, the largest exclusive manufacturers of underground conduit in the world, the factories of the latter company having an annual output capacity of 40,000,000 duct feet.

Capt. Barnard has been fortunate in securing the services of Mr. E. T. Kirkpatrick as vice-president of the B. S. Barnard Company, and general manager of the Chicago office.

"Kirk," as he is familiarly known throughout the entire electrical field, attained his experience with the General Electric Company, the Westinghouse Electric and Manufacturing Co., and the Fort Wayne Electric Co., and for the past seven years has devoted himself to the field of underground clay conduits, his field of operation being throughout the middle west. Capt. Barnard and Mr. Kirkpatrick will have a very impressive exhibit at the coming Electrical Show in Chicago and also at the Convention of the Independent Telephone Manufacturers, to be held later in the same city.

To use a football expression, the Captain and "Kirk" are a couple of ground gainers in the conduit field, who have never yet been thrown for a loss.

Dossert & Company, of New York City, manufacturers of the now well-known Dossert Solderless Joints, the only solderless joints officially approved by the National Board of Fire Underwriters, have just received a large order for their solderless cable terminal lugs from the Westinghouse Electric and Manufacturing Company, for use in the new Hudson Terminal Buildings in New York City. These lugs are to be furnished in sizes for use on cables of 1,350,000 circular mils. The above company has also just received an order from the H. Krantz Manufacturing Company, of Brooklyn, manufacturers of switchboards, for a number of smaller solderless lugs in sizes for cables up to 350,000 circular mils, which will be used in the new City Investing Building, one of the highest office buildings in New York City. This order also includes a number of swivel solderless lugs, which admit of any alignment of the cables that may be desired.

McKenney & Waterbury Company, of Boston, Mass., the largest manufacturers of gas and electric fixtures in New England, have just issued a most artistic calendar, which they are mailing to all their friends. If yours has gone astray in the mails, tell them about it.

The electrical fraternity generally will be glad to learn that the recent litigation regarding wireless clusters between the Dale Company, the largest manufacturers of electric and combination fixtures in this country, and the Benjamin Electric Co., of Chicago, has been, at least for the present, amicably settled. Although the Dale Co. does probably the largest business in wireless clusters in this country, this particular branch of their business amounts to but about one-twelfth of their total output in the fixture line.

It is the opinion of the best legal experts in the country that, should the Dale Co. care to carry the case to the Supreme Court, the decision of the Court of Appeals could not be sustained.

Such a procedure, however, necessarily takes time and for business reasons, therefore, the Dale Co. has entered into its present arrangement with the Benjamin Company for the benefit of their customers who are the largest buyers in this country.

Voltax, the well-known anti-corrosive compound, manufactured by the Electric Cable Company, 17 Battery place, New York City, has been specified by the Bridge Department for the painting of the Brooklyn Bridge.

American Institute of Electrical Engineers

At the last meeting of the American Institute of Electrical Engineers held in the auditorium of the Engineering Societies Building, No. 33 West Thirty-ninth street, New York City, Friday, January 10, 1908, at 8 P. M., the following papers were presented for discussion:

1. "The New Haven System of Single-Phase Distribution, with Special Reference to Sectionalization." By W. S. Murray, electrical engineer, New York, New Haven & Hartford Railroad.

2. "A Single-Phase Railway Motor." By E. F. Alexanderson, electrical engineer, General Electric Company, Schenectady, N. Y.

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A special meeting of the Institute will be held in the auditorium of the Engineering Societies Building, Friday, January 24, 1908, at 8 P. M.

At this meeting the following papers will be presented for discussion:

1. "Electrical Engineering Education." By Charles P. Steinmetz, chief electrician, General Electric Company, Schenectady, N. Y.

2. "The Best Engineering Education," by Charles F. Scott, consulting engineer, Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.

A new departure has been made by the Weston Electrical Instrument Company in the production of accurate and yet low-priced ammeters and voltmeters for switchboard work. The direct-current instruments are called the Eclipse type. They work on the "soft-iron" principle, but have been designed after years of investigation to eliminate the disadvantages ordinarily possessed by such instruments. The alternating-current instruments work on similar lines. This is the first alternating-current ammeter produced by this company, it having been found impossible heretofore to construct such an instrument possessing sufficient accuracy. The new instruments are dead-beat, very sensitive and are practically free from hysteresis error. They are made in two sizes, one for large and the other for small switchboards. The ammeters are made in 16 ranges from one ampere to 500 amperes capacity. The voltmeters are made in seven ranges from 75 to 750 volts full scale deflection.

The Industrial Outlook

"It is daily becoming more apparent," said President W. H. Whiteside, of the Allis-Chalmers Company, in a recent interview, "that the general business of the country has not been so seriously injured by the recent sudden financial depression as the public has been inclined to believe. And I am firmly of the opinion that the thing now most necessary is to loosen the chains of conservatism and give courage an opportunity to assert itself and make advances consistent with the generally prosperous conditions and well-distributed resources of the country. As the production and use of basic machinery, such as prime movers for the generation of power, is a very potent and leading factor in our commercial activities, very naturally it is one of the first lines of business to be affected when the pendulum swings from optimism to pessimism, and likewise the first to feel the effect when the change in sentiment again manifests itself. The number and character of inquiries which our offices, located in the principal commercial centers of the country, have recently been receiving convincingly demonstrate a return of confidence, and bear evidence that not only a diversified but a large volume of business will be offering ere the middle of the first quarter of 1908 has been passed.

"Until within a few months manufacturers everywhere in the United States found themselves urgently in need of increased facilities for carrying on their own business, and when they are again called upon to supply the normal demands of business, and to replenish stocks in the hands of jobbers and retailers, many of which are now nearing the point of depletion, they must, of necessity, again work their plants to the full of their present capacities, and add increased machinery equipment, the plans for which in numerous instances are already well matured.

"The railroads of the country, whose policy of retrenchment has continued for approximately a year, notwithstanding the largest offerings of traffic, with resultant increased earnings, in their entire history, must shortly be compelled to again enter the maret and make large expenditures for renewals, including train equipment, steel rails and general supplies. This, coupled with the approaching need for the renewal of stocks of metal employed in all branches of industry, which, through shutdowns of furnaces and smelters and the continued use of iron, steel and copper for current consumption, have now been lowered very near to the minimum, and giving due consideration to the large balance now in our favor in our commerce with foreign nations, and to the well-distributed revenues from our exceptionally large agricultural products, cannot fail to create an early demand for new machinery and auxiliary equipment.

"The outlook is, therefore, distinctly encouraging."

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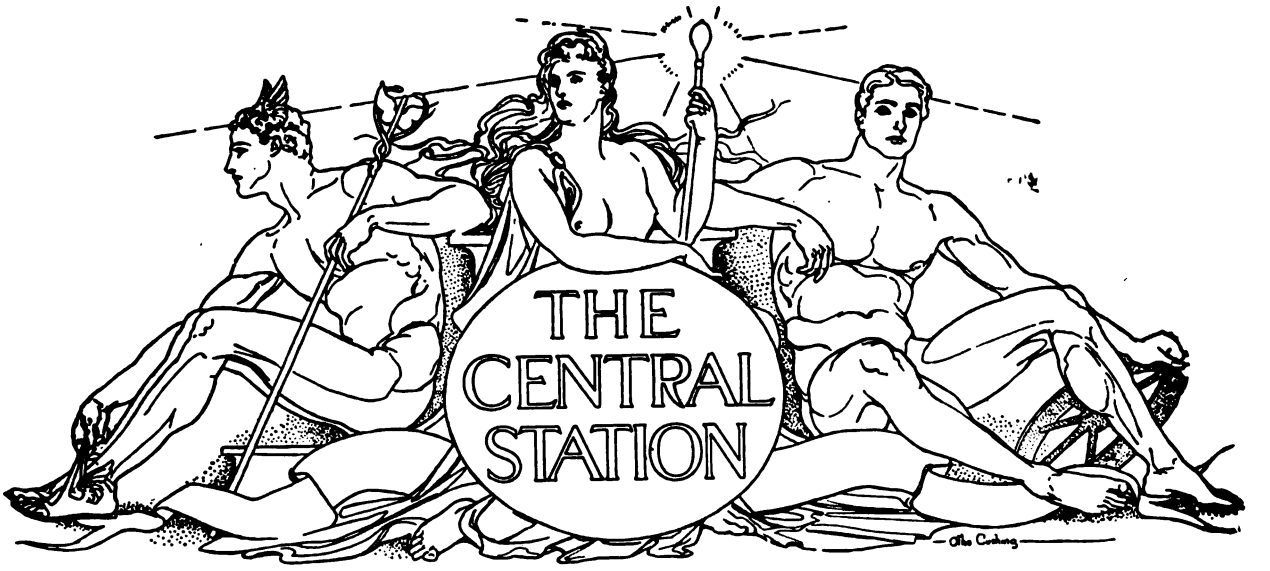

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, No. 8. NEW YORK, FEBRUARY, 1908. ISSUED MONTHLY.

The Central Power Station at the Plant of Walter Baker & Co.

BY C. A. TUPPER.

The establishment of Walter Baker & Co., Ltd., at Dorchester, Mass., a suburb of Boston, embraces a number of mills engaged in the manufacture of chocolate and cocoa products. They are located at the crossing of Washington Street and the Neponset River, about six miles from the center of Boston, and embrace plants on opposite corners of the street and the stream, known as the Baker mill, the Webb mill, the Pierce mill and others. These mills are large plants in themselves, which have, until recently, been operated by independent steam plants. In each case the engines were pairs of horizontal simple condensing and non-condensing engines, supplied with steam by horizontal return tubular boilers, but it was some three years ago decided to have an economical central plant. For this purpose an extensive new power station has been built for the operation of all of the mills as a single unit, by means of which a maximum of economy and reliability might be attained.

The new power plant, of which the following description is furnished by Allis-Chalmers Co., through courtesy of F. W. Dean, the Consulting Engineer and Architect, has been located apart from the mills, so as not to interfere with future extensions and additions to the mills, and so that the latter may not, in any way, be dependent upon power considerations. It is situated on the northerly bank of the Neponset River upstream from the mills, where the stream is several hundred feet in width and an ample supply of circulating water is available. The river water is of such a quality that it is used for feed for the boilers as well as for condensing. Convenient rail connections were also available at this point, for receipt of fuel and for handling machinery.

The plant is laid out on the cross-boiler room principle, with a 60 x 80-ft. main engine room and a 57 x 96-ft. boiler house extending at right angles from one end. It is constructed of brick on concrete foundations throughout, and has a wooden roof supported on steel trusses. The architecural treatment of the exterior is simple, yet productive of pleasing results, a feature of which is the liberal provision of windows for interior lighting. The roofs are covered with tarred paper and gravel and are nearly flat, draining to the outside with inside gutters. The interior is finished with common red brick painted

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with cold water paint in the boiler room, while in the engine room the finish is red pressed brick with limestone trimmings, by means of which an attractive interior has been secured. In the latter room the roof planking is concealed by sheathing of matched North Carolina pine. For the handling of machinery a 10-ton hand-painted traveling crane of 59-ft. span covers the engine room, traveling on 20-in. I-beam tramways, which are supported upon ornamental pilasters in the wall construction at frequent intervals.

The plant has been designed for an ultimate capacity of 2,800 h.-p. in boilers, and 1,750 kw. in electrical generating machinery.

The two large units are vertical cross-compound engines built by the Allis-Chalmers Co., which have 22 and 48-in. cylinders with 48-in. stroke. They are both direct-connected to 750 kw. alternating-current Allis-Chalmers generators, which are mounted alongside of the 15-ft. flywheels on the engine shafts. The smaller generating units consist of simple horizontal 18 x 26-in. engines, direct-connected to Allis-Chalmers 125 kw. alternators. There are, in addition to the above, two steam turbine generator sets of 50 kw. capacity each, which, together with a motor-generator set of equal capacity, are utilized for excitation purposes. The large engine units are supplied with steam by 8-in. connections from the boiler room main, while the small horizontal units have 5-in. connections and the turbines 3-in. connections from the basement steam main. The larger units exhaust, as above stated, to the condensing units in the basement and the small engines to the low-pressure main in the basement. A noteworthy feature of the engine installation is the use of reheaters for compound engines, which are supplied with heat by the hot gases passing from the boilers to the stack. These reheaters consist of large cylindrical receivers, each fitted with a large number of 6-in. boiler tubes through which the hot gases are passed. They are located, as previously stated, on the concrete platform in the boiler room, elevated 13 ft. above the floor to facilitate connections to the fuses and economizer. The smoke connections are led to both reheaters in multiple, while the steam connections are separate, one reheater serving for either engine. The latter connections consist of 10-in. lines from the exhaust side of the high-pressure cylinders, and 18-in. return lines from the reheaters to the admission side of the low-pressure cylinders, the steam being superheated about 30° Fahr. in passing through the reheaters under ordinary conditions. The oiling of the compound engines is accomplished by gravity from an elevated tank, the oil after passing the engines flowing by gravity to a filter in the basement, from whit it is returned to the elevated tank again by a small duplex pump.

The condensing equipment consists of two surface condensers, one serving for each of the compound engine units, to which circulating water is supplied from the Nepcnset River by two electrically-driven centrifugal pumps. The condensers have separate 5¾ x 4¾ x 5-in. duplex condensation pumps located in a pit under the hot wells, which deliver to the feed-water heater in the pump room. Each condenser is operated with a dry vacuum pump, which draws from the top of the condenser casing through 4-in. lines and discharges through a common 4-in. line ending in the circulation water overflow outlets. The 6 x 8-ft. intake well is depressed in the basement floor at the southeast corner next the river, 16 ft. below the engine room floor level, and has a connection to the river alongside by a 36-in. cast-iron pipe extending through the building wall foundation at that side. This intake pipe is provided with a valve so that the water can be shut off and the well pumped out and cleaned, and the well also has two sets of removable copper screens on the inner end of the inlet pipe.

The generating machinery is now all in place, but owing to the present requirements of the mill, but a part of the steam generating capacity has been installed. The latter consists of vertical fire-tube boilers in 200 h.p. units, for which space has been provided in the boiler room for two rows of seven on either side, facing a central firing floor. Of these, five are installed on each side at the end of the boiler room nearest the engine room. Special features of the steam plant are the use of the vertical fire-tube boilers, hot gas reheaters for reheating the intermediate stage from the compound engines and flue gas economizers. The hot gas reheaters are located on an elevated platform at the engine room end of the boiler room, and the economizer in a 17 x 86-ft. annex to the southerly side of the boiler room. The boiler room proper is 40 x 96 ft. in size and has a clear headroom of 36 ft. under roof trusses, there being no basement, although there is, under the elevated platform carrying the hot gas reheaters, a 13 x 42-ft. space with 12½ ft. clear headroom in which are located the boiler feed pumps and heater. The main engine room, which is 60 x 80 ft. in size, has a headroom under the roof trusses of 40 ft. to provide for vertical engines and the traveling crane above, and a basement with

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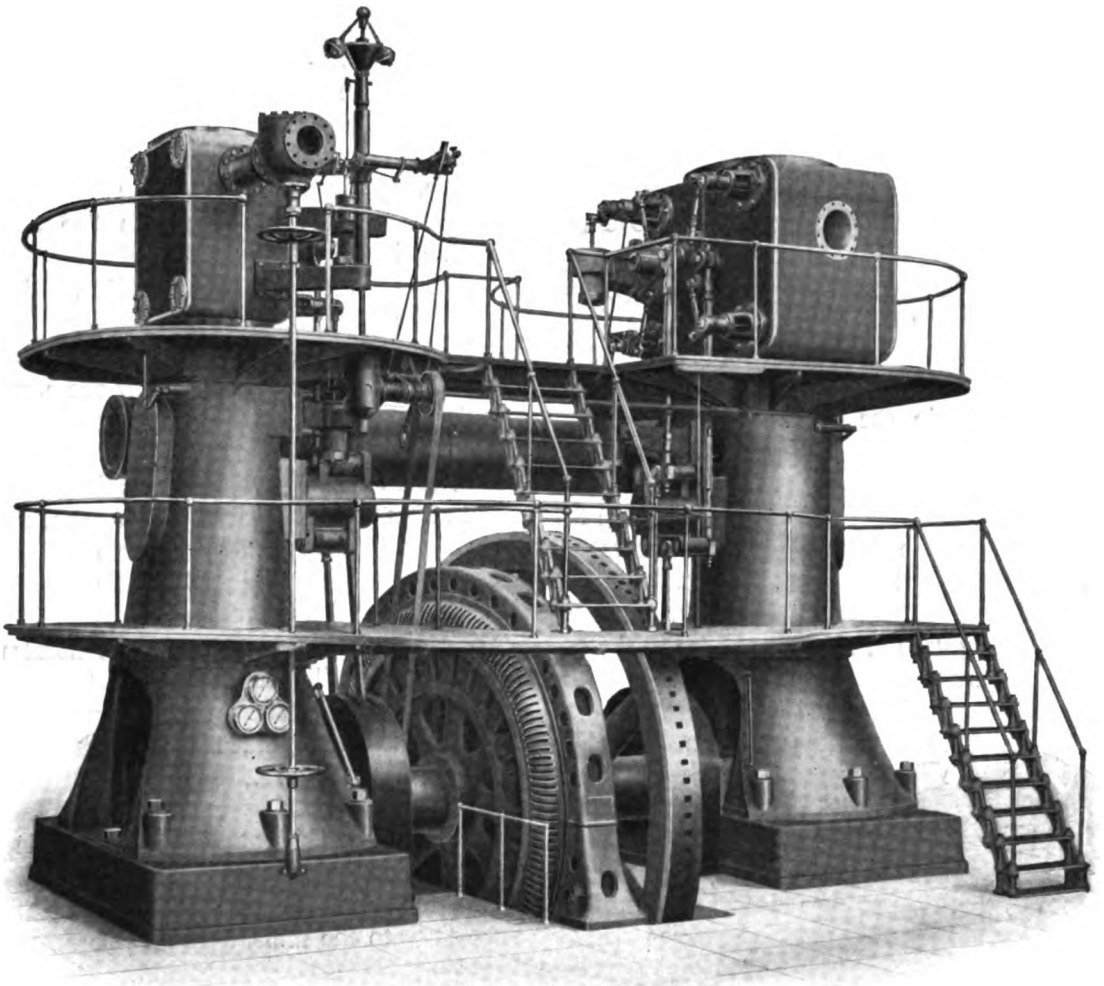
10-ft. minimum headroom, accommodating condensing equipment and piping.

The boilers have 8-ft. shells standing 26½ ft. above the floor and have 308 2¼-in. tubes 15 ft. long, which present an effective water heating surface of 2,000 sq. ft. They are internally fired, having grates 7 ft. 4 in. in diameter with combustion spaces 6 ft. above the grate level. They are arranged for hand firing, coal being wheeled into the boiler room, which, together with the handling of ashes, is greatly facilitated by the use of a central firing floor with rows of boilers on either side. The products of combustion are removed by a 200-ft. brick stack of 8 ft. interior diameter, which is located at the rear corner of the boiler house and is connected to the boiler smoke boxes by an overhead flue. The flue is of ⅛-in. steel, suspended from the steel roof trusses, and ranges in size from 6 x 4 ft. at one end of the boiler room to 6 x 8 ft. at the other, where connection is made to the hot gas reheaters and thence to an economizer in the side addition to the boiler house, which extends back to the stack at the rear end. The connections from the flue to the boilers are 20 x 60-in. ducts which connect with the side of the smoke boxes so that the entire top of the latter is left free for removal for access to the boiler tubes. From the large end of the flue two 40 x 80-in. connections are taken to the tops of the hot gas reheaters, from the bottom of which ducts of similar cross-section lead across into the annex building, to connect with the economizer. Both of the reheaters have 40 x 80-in. dampered by-passes and the economizer has a by-pass 8 ft. square formed under the concrete



ALLIS-CHALMERS ALTERNATING CURRENT GENERATING UNIT.

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platform on which it is supported. The damper regulator is located at the point of connection of the economizer flue to the stack. The fuel supply for the plant will be stored in the yard outside the plant from which it will be brought to the boiler room by a telpherage system.

The boiler feeding equipment consists of two duplex outside end packed feed pumps, a Cochrane feed-water heater and purifier and a Sturtevant economizer, all of which have been installed of sufficient capacity provided for the total projected boiler plant of 14 boilers. The pump and the heater are located in the space underneath the elevated platform carrying the hot gas reheaters, and the economizer in the side addition to the boiler room, in which it is mounted on a concrete platform 8 ft. above the floor level and is 44 ft. in length. The feed pump suction connections are so arranged that the pumps will ordinarily draw through 6-in. suctions from the feed-water heater into which the condensation from the surface condensers is delivered by condensation pumps in the engine room basement. Make-up water is added from the city water system, from the circulating water or from the pond directly. The feed heater is supplied with steam from the exhaust delivery line from the small generating units and auxiliary steam-using machinery in the plant to which it is connected inductively, low-pressure steam being used in large quantities in the various mills for manufacturing purposes. The atmospheric relief connection from this low-pressure line is made through the feed heater, a 6-in. relief line with two Schutte back-pressure valves connected in multiple being extended from the top to the 12-in. atmospheric exhaust riser, which serves the main engines of the plant. Watts reducing valves admit live steam to the low-pressure system as needed to maintain the pressure. The feed pumps deliver through a 5-in. line which extends to the economizer, with, of course, a by-pass connection direct to the boilers. The latter is a ring main of 4-in. brass pipe, which is laid out to encircle the boiler room, although at present it has been extended only so far as the boiler units now in place. The boiler branches are 2-in. brass connections, which are brought from the main at the rear around to the front of the shells, through which the connection is made at a point about 2 ft. above the crown sheet, through two valves and a check valve, permitting access to the latter while the boiler is in service. A feature of the water connections to the boilers is a cold water main paralleling the ring feed main, from which a connection is made to each boiler for purposes of washing out and for filling up after washing, consisting of a 2-in. branch with stop and check valves; it is supplied directly from the city water main. Feed pumps have an emergency delivery connection to this main to permit feeding to the boilers in this way if anything should happen to the regular feed main. The boiler blow-off system consists of a 4-in. cast-iron blow-off main located in a trench at the rear of either row of boilers, which connect with a cross line of similar size at the forward end of the room, leading to discharge into the river alongside. The boilers have 2½-in. blow-off connections into the main, each consisting of two Morris blow-off valves connected in series. The economizer has a 4-in. blow-off connection which delivers into this line at a point near the side of the building, while the feed heater has an independent 4-in. blow-off line, which is carried in the same trench to the point of discharge.

The high-pressure steam piping system consists of an 8-in. ring main in the boiler room, with 4-in. supply connections from each boiler, and has delivery connections to the main engines in the engine room, to the auxiliary machinery in the basement and to high-pressure delivery lines to the mills. The ring main is supported by hangers from the roof trusses at a level considerably above the tops of the boilers, the boiler branches consisting of double long radius bends from the steam nozzles at the front of the shell around the sides to the rear and up to the main. The two large vertical engines are supplied independently by 8-in. connections which are carried up at the division wall end of the boiler room to 30 x 42 in. receiver separators extending thence through the walls to the throttle valves. For the supply of the small horizontal engines, the auxiliary machinery and the high-pressure lines to the mills, a 10-in. line extends down into the engine room basement, from which an 8-in. branch extends to the mills and a 7-in. line to the auxiliary machinery and the horizontal engines. From the latter line steam is supplied also to the auxiliary equipments, including the dry air pumps of the condensing equipment, the condensation pumps and the boiler feed pumps.

The exhaust piping of the plant is simple. For the large engines there are direct 22-in. connections from the low-pressure cylinders through the floor to independent surface condenser units in the basement, in each of which connections there is an automatic relief valve, delivering to 12-in. lines to a common atmospheric riser and exhaust head above the boiler room. In each of the 22-in. exhaust

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connections from the engines there is inserted close to the condenser a 24-in. Cochrane oil separator, for the purpose of freeing the exhaust steam from lubricating oil entrained from the engine cylinders and thus preventing contamination of the boiler feed. The auxiliary exhaust system starts in an 8-in. connection to the intermediate stages of the large vertical compound engine units at points where the exhaust from the high-pressure cylinders enters the hot gas reheaters. From here the line drops into the pump room, where it is joined by the 3-in. exhaust from the feed pumps, and enters the Cochrane open feed-water heater through an oil separator. The line then extends into the engine-room basement, where it is joined by an 8-in. main serving the horizontal generator engines, the exciter engines and the condensation pumps, and continues as an 8-in. line to the mill buildings for the low-pressure steam supply. There is a reserve connection to this low-pressure main from the live steam header in the engine-room basement, consisting of a 4-in. Watts reducing valve with by-pass, thus permitting live steam to be added in case of deficiency of the exhaust. The low-pressure supply will ordinarily be furnished by the small engine units and the auxiliaries, the connections to the intermediate stages of the compound engines being for the purpose of adding to this supply without the use of live steam and still without sacrificing the advantages of operating the large engines condensing.

The Allis-Chalmers generators deliver three-phase, alterating current at a potential of 600 volts, at which voltage current is transmitted directly to the mills for power and lighting purposes. The power feeders and the machines are controlled from a blue Vermont marble switchboard 60 feet in length, which contains panels for the generators and feeders, and totalizing instrument panels. All circuits to the different mills have recording meters for measurement of the power supply to each department separately. The mills are operated entirely by induction motors, of which there are about 100 installed, ranging from 1 to 75 hp. and arranged for both individual and group driving. The lighting is done on the two-wire system at 110 volts, the voltage being reduced from the power feeder lines by transformers at each mill. The power feeders are carried to the mills through a steel bridge to the Baker mill, from which they pass over a bridge across the river to the Webb mill and through a subway some 200 feet in length under Washington St., to the Pierec and other mills.

This power plant and the new power and lighting equipment of the various mills was designed and the construction superintended by Mr. F. W. Dean, mill engineer and architect, of Boston, Mass., formerly of the firm of Dean & Main.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability for Death or Injury from Electric Current, Continued—Duty and Liability to the General Public—Wires in Highways, Continued

A frequent excuse for liability is the fact of an unprecedented storm, and this is a valid excuse if there was not negligence in the repair or construction of the line so that it became an easy prey to the storm, and unless the havoc wrought by the storm is suffered to go without repair for so long a time that the owner is charged with negligence in not sooner repairing the damages. Mitchell vs. Charleston Light & Power Co. (S. Car.), 31 L. R. A., 577.

Generally speaking, the question is one for the jury to decide as to whether or not the company should sooner have discovered and repaired the injury, and it was so held where the storm occurred

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during the night and the injury occurred at six o'clock in the morning. Cook vs. Wilmington City Electric Co., 9 Houst. (Del.), 306.

To the same effect upon almost precisely similar facts is Texarkana Gas, etc., Co. vs. Orr, 59 Ark. 215. In this case, however, it was shown that the electric company had by tests made at the power-house discovered a "ground" along the line somewhere, but had not followed up the tests so made to learn where the ground was.

A common failure of construction which produces injury and subsequently liability has already been considered, but should be further emphasized, and is the failure to place guard wire lines. This has been repeatedly held to be a reason for holding a company liable which is not otherwise negligent. Godfrey vs. Streator Ry. Co., 56 Ill., App., 378, Larson vs. Central Ry. Co., 56 Ill., App., 263, McKay vs. Southern Bell Telephone Co., 31 L. R. A., 589, United Electric Ry Co. vs. Shelton 89 Tenn., 423, Block vs. Milwaukee Street Ry. Co., 89 Wis., 371. Where it was held that the lack of guard wires between trolley and telephone wires will render a street car company liable to one who is injured by coming in contact with a broken telephone wire which has fallen across the electric light wire.

LIABILITY OF THE ONE WHO BREAKS THE WIRE.

Those who cause the breaking of a wire may be held liable instead of the electric company where the breaking is due to their negligence, as where the telephone wire is broken by a trolley pole causing it to fall across the electric wire. Kankakee Electric Ry. Co. vs. Whittemore, 45 Ill., App., 484.

CONTRIBUTORY NEGLIGENCE.

The most important of the defences to actions in this field is that of contributory negligence and depends upon the ordinary principles which govern this subject; generally speaking, one who in any way by neglect to exercise the care which an ordinarily prudent man would exercise under like circumstances and who is injured may not recover. Subsequently if one injured in person or property by a live electric wire might by the exercise of such care as an ordinarily prudent man would have exercised under the same circumstances have avoided the injury, he is precluded from recovering therefor. The ways in which this question has been presented are as various as the cases; thus the one line of division which seems to be possible is that which separates the case in which persons of immature years were injured from the class in which adults are concerned; the latter of these will be considered first, as it involves the most variety of circumstances and logically leads to the consideration of the other class. Generally speaking, the question as to whether or not the person injured contributed to his injury by his own neglect is not a question purely of law to be decided by the court, but is a question of fact requiring for its decision an interpretation of the evidence in the particular case at bar and consequently must be disposed of by the jury.

In extension of this doctrine it was held in Bourget vs. Cambridge, 156 Mass., 393, 16 L. R. A., 605; and Cook vs. Wilmington City Elec. Co., 9 Houst. (Del.), 306, that the negligence of one who was shocked upon taking hold of a loose telephone wire which he had stooped down and picked up to throw out of the highway was for the jury to determine, and it was held improper for the court to charge in favor of defendant upon the theory that as a matter of law complainant was guilty of contributory negligence, likewise where the driver of a horse failed to see a broken telephone wire in the street where the horse stepped on the wire and was killed, was not so clear an evidence of want of care on the driver's part as to preclude a recovery by him for his horse. Kankakee Elec. Ry. Co. vs. Whittemore, 45 Ill., App., 484 As the driver of a vehicle is entitled to assume that the street is free from dangerous obstructions, like a telephone wire lying across a trolley wire, he is not guilty of contributory negligence in failing to see such wire before his horse steps on it and is killed. Jones vs. Finch (Ala.), 29 S. O. Rep., 182.

Likewise whether a woman pedestrian was guilty of contributory negligence in failing to see a wire ⅜ of an inch thick lying in the street and avoided stepping on it is for the jury, although the time was eight o'clock in the forenoon, and should not be decided by the court as a question of law. Devlin vs. Beacon Light Co., 192 Pa., St. 188.

In Brush Elec. Light Co. vs. Kelley, 126 Ind. 220, 25 N. E. Rep. 812, it was held that a pedestrian walking along the sidewalk in the daytime was not guilty of contributory negligence as a matter of law in falling over a small wire lying along the sidewalk, as he might well assume that the walk was safe, and knowing nothing to the contrary, was not careless in permitting his attention to be attracted for a moment by something which would attract the attention of a reasonably prudent person. The court said "a small wire lying along a sidewalk might very reasonably be overlooked by a passer-by who has no notice thereof, and the fact

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that it is overlooked does not necessarily indicate negligence."

It will thus be seen that a question of contributory negligence is for the jury where the person injured did not see the wire from which the current came that caused his injury. That is, the jury is to say whether in view of all the circumstances of the case he should have seen and avoided the wire. The use of these words "circumstances of the case" presents the problem with which the jury must wrestle; it is for them to say whether under those circumstances a reasonably prudent man should have seen the wire and avoided it. It has been determined by these decisions that one is not guilty of contributory negligence as a matter of law in failing to see a wire in the street upon the theory that he was not bound to look for it, as he was entitled to presume that the street or sidewalk was free from obstructions. More of this question of contributory negligence by failing to see the wires will be heard from later on when the question of liability to persons who come in contact with electric wires on private property is under discussion.

Liability of Electric Light Company for Falling of a Lamp

"Action was instituted by the next friend of appellee for damages, the result of an injury he received, at a point where Webster street and Story avenue cross in the city of Louisville, by a lamp falling on him, which was suspended over the crossing by appellant to one of its wires. The lamp dropped about 20 feet. It was made of glass and iron, and weighed 35 or 40 pounds. Appellee was driving his wagon at the time along the street. The lamp struck him on the left side of the head, and on the left shoulder, which caused him to lose the use of his left arm. Several physicians testified that in their opinion the arm was permanently disabled. At the time the accident occurred an employee of appellant, McGill, had just lowered the lamp from its position on the wire, and at the moment he elevated the lamp to its position on the wire the rope broke within about six inches of the lamp, which let it fall on appellee. Whether McGill caused it to fall or what caused the rope to break does not appear. Appellant by its answer admitted the falling of the lamp and the injury to appellee, and alleged that the fall was not caused by the negligence of any want of due care upon its part. This was controverted. Appellant upon this issue introduced three witnesses, namely, its superintendent, a member of the firm from which it bought the rope, and McGill, the employee who kept the lamps in proper condition for lighting. The superintendent testified the rope had been in use seven or eight months; that it ought to have remained in good condition for about two years; that it was of the best quality of tarred manila rope, and either three-eighths and one-half inch in diameter; that he bought it from a reputable firm. A member of the firm testified to the same effect. McGill testified that he let this lamp down every other day, and looked at it and he could see nothing wrong with it; that it appeared to him to be in proper and safe condition."

"Appellant filed grounds and moved the court for a new trial. The court overruled the motion, and delivered the following opinion, which admirably sums up the facts of this case: 'The evidence of the defendant showed: That the rope which broke and caused the injury was either a three-eighths or one-half tarred manila, and was bought from a reputable dealer. If it was three-eighths, it would safely sustain a weight of 400 pounds; if one-half, a weight of from 600 to 800 pounds. That it had been in use only six or eight months, and was inspected every second day, and that the life of such for the purpose it was then being used was not less than two years; yet the rope broke under the strain of raising an electric lamp weighing 30 or 40 pounds. With such evidence before them from the defendant's witnesses, the jury might well conclude that an inspection of the rope made with ordinary care by a reasonably competent man, must have disclosed the defect which caused it to break under a strain relatively so insignificant.' Under the pleadings and facts stated the presumption was that appellee's injuries resulted from the negligence and want of care of appellant's servants, and the burden was upon it to show to the contrary. When a thing which causes injury is shown to be under the management of defendant, and the act is such as in the ordinary course of things does not happen, if those who have the management use proper care, it affords evidence in the absence of explanation of the defendant that the accident arose from want of care. See Sherman & Redfield on Negligence, 60. The happening of an accident, which in the usual and ordinary course of things would not happen with proper care, cast the burden on defendant to explain the accident so as to relieve itself from liability. We have examined the testimony in this case with care, and

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have been unable to find any evidence giving any reason or cause why the lamp fell. It was not shown that the rope was rotten, or that it had been worn by use that caused it to break, or whether there was some latent defect in the rope that could not have been ascertained by ordinary care. There was not one witness who professed to have examined the rope after the lamp fell, and no one attempted to state the lamp was caused to fall by the manner of its use by McGill. There was no evidence introduced showing that McGill was skilled in that business or prudent and careful, nor did McGill attempt to give reason why the lamp fell. For appellant to have relieved itself from liability it was necessary for it to show that McGill, the person in charge was reasonably prudent and skilful in that business, and to have given some explanation why the lamp fell at that particular time. In other words, that the rope had a latent defect which could not have been discovered by a person with reasonable skill and prudence in that business, and this appellant failed to show."

Louisville Lighting Co. vs. Owens (Ky.), 105 S. W. Rep., 435.

Electrical Engineering Education

By Charles P. Steinmetz.

When in the following I dwell more on those features of our electrical engineering education which appear to me unsatisfactory, it is not that I overlook the many good points, but rather that a criticism of the few defects appears to me more important, for the purpose of urging their elimination.

In general, the conditions for a good electrical engineering education in the United States are far more favorable than anywhere else; for an electrical engineering industry developed to a higher degree and to a greater magnitude than in any other country offers a very large field of application to the graduate engineer, thus applying an incentive to enter this profession. Unlike other countries, where some opposition to the college-trained man, as unpractical, still lingers, the electrical industries here prefer, and in many instances demand, a technical college training for their engineering staffs. There is a tendency now to demand this training even for administrative and commercial positions. This leads to a close coöperation between the electrical industry and the engineering college. The leaders of the industry take a close and active interest in technical educational work, while teachers of engineering consider it as their foremost duty closely to follow and keep informed of the advances of the electrical industries, sometimes even are actively engaged in industrial work; and as early as possible the students are introduced to the industry, by visits to factories, inspection trips, etc., which become more and more an important part of the college education. This is as it should be, and probably constitutes the strongest features of American engineering education.

While many, especially smaller colleges, are not financially strong, in general the means available to the American college of engineering are far superior to those abroad, and especially in erecting engineering buildings, laboratories, etc., much has been done.

The great defect of the engineering college is the insufficient remuneration of the teaching staff: the salaries paid are far below those which the same class of men command in industrial work, and as result the college cannot compete with the industry for its men, but most of the very best men are out of reach for the colleges. The teaching forces of the colleges therefore consist of: 1, A few of the very best men, who are specially interested in educational work to such an extent that they are willing to sacrifice financial returns for it. These men have made the engineering college what it is; but even many of these men are ultimately forced by considerations of family, etc., to leave college work and enter industrial employment. 2. Many younger men interested in teaching, enter college work to give it a trial. Some of these remain, but many return to industrial work, when they are forced to realize the small prospect of financial return offered by the college. 3. First-class men who devote a part of their time to the college and a part to industrial work, usually consulting engineering. This arrangement is probably the best for the college, handicapped as it is by the policy of salaries which may have appeared sufficient in branches in which

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no industry competes, but which are suicidal in the engineering department. Still it would be far preferable if the colleges could get the benefit of the whole time and the undivided interest of these men.

It appears to me, therefore, that a vast improvement could be made in electrical engineering education if a large part of the sums which now are devoted to marble engineering buildings and fancy laboratory equipments could be devoted to offer such salaries as to make available to the colleges the undivided time and interest of the best men in the field. The name of the donor may just as well be perpetuated by the professorship which he endows, as by the pile of marble which he erects for the college. After all, engineering buildings and college laboratories are of very secondary importance compared with the qualifications of the teacher and his assistants.

To the subjects taught and the methods of teaching very grave objections may be made. The glaring fault of the college curriculum is that quantity and not quality seems to be the object sought; the amount of instruction crowded into a four years' course is far beyond that which even the better kind of student can possibly digest. Memorizing details largely takes the place of understanding principles, with the result that a year after graduation much of the matter which had been taught has passed out of the memory of the student, and even examinations given to the senior class on subjects taught during the freshman and sophomore years, reveal conditions which are startling and rather condemnatory to the present methods of teaching.

It stands to reason that with the limited time at his disposal, it is inadvisable for a student to waste time on anything which he forgets in a year or two; only that which it is necessary to know should be taught, and then it should be taught so that at least the better student understands it so thoroughly as never to forget it. That is to say, far better results would be obtained if half or more of the mass of details which the college now attempts to teach, were dropped; if there were taught only the most important subjects—the fundamental principles and their application—in short, all that is vitally necessary to an intelligent understanding of engineering, but this taught thoroughly, so as not to be forgotten. This, however, requires a far higher grade of teachers than are needed if the mere memorizing of textbook matters, reciting them, at the end of the term passing an examination on the subject and then dropping it. The salaries offered by the colleges are not such as to attract such men. When the student enters college he is not receptive to an intelligent understanding, for after a four years' dose in the high school of the same vicious methods of memorizing a large mass of half and even less understood matters, the student finds it far easier to memorize the contents of his text-books than to use his intelligence to understand the subject-matter. After graduation, years of practice do for the better class of students what the college should have done—teach them to understand things. It is, however, significant that even now young graduates of foreign universities, in spite of the inferior facilities afforded abroad, do some of the most important electrical development work of this country. Men who never had a college education rise ahead of college graduates. This would be impossible if our college training gave what it should, an intelligent understanding of electrical engineering subjects.

The cause of the fault is perhaps the same that leads to the erection of engineering buildings and laboratories while underpaying the teaching staff; the competition among the colleges. To the father who looks up a college for his boy, marble engineering buildings and fancy laboratories are impressive, and so is an extensive curriculum; the result is a rapid increase in the number of students; but it is not to the benefit of the student, since the faster a subject is learned the faster also it is forgotten, and to become and remain thoroughly familiar with a subject, it is necessary to keep up the study of it for some years. While it is a good feature to insure application of the student by term examinations, etc., this becomes harmful if it leads to dropping the subject at the end of the term. The least that can be expected from the college is that at the time of graduation the student still knows all that he has been taught during his college years. To accomplish this it is necessary to keep up the study of every subject to the end of the college course. This is not the case at present.

The different colleges vary between the school teaching the trade of electrician, and that attempting to give an intelligent electrical engineering education. At the one extreme is the college which dropped from its curriculum everything not required in electrical engineering. Such a school covers a large ground in electrical engineering, may even consider shortening the course to three years. The graduate of such a course is a full-fledged electrical engineer, capable to ply his trade, just as a plumber or brick layer when graduating from his apprentice years, and just as helpless and useless when any occasion arises requiring general knowledge to enable

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him to understand matters beyond his trade. The unavoidable result of such training is, that when with the development of the industry subjects become of importance which were not considered as pertaining to the trade of electrical engineering during his college years, his usefulness is impaired, younger men rise above him, and he cannot hope to rise beyond a subordinate position. Fortunately, the better technical colleges realize that the first requirement of an electrical engineer is a thorough general education, and begin to realize that for this purpose it is not sufficient to require general subjects for college entrance and relegate their study to the high school; for even if the average high school were what it should be and not what it actually is, much of the general knowledge required by an educated man cannot be taught in the high school, since during the high-school years the intelligence of the boy is not sufficiently ripened for its grasp, and a review in the college is necessary.

However, even if an attempt is made to teach or to review general subjects, the work is not carried sufficiently far. Mechanical engineering, physics, chemistry, and some civil engineering subjects are recognized as legitimate subjects of teaching in the electrical engineering course in many colleges, together with literature, some history, etc.; but physiography, physical geography, meteorology, mineralogy, astronomy, etc., are also of importance in a general engineering education. The failure to recognize this may sometimes be a severe handicap to the electrical engineer, and that in the not very far future, judging from the present trend of development. In this direction the student, as well as his parents, are frequently antagonistic, and cannot see why subjects should be studied, which to their limited horizon appear unnecessary.

The instruction given in those branches of science, a knowledge of which is required by the electrical engineer, but to which only a limited time can be devoted, as chemistry, civil engineering, etc., frequently is very unsatisfactory, being unsuited to the requirements of the electrical engineer, and, as result, of very little if any value to him. A general knowledge of these branches is required, so as to familiarize the electrical engineer with the general problems, methods, and purposes of the science; to enable him to understand subjects dealing with these sciences. The ability actively to practise the science is not required. To illustrate in the case of chemistry: the electrical engineer should have a knowledge of the laws of chemistry, a familiarity with the elements and their compounds, and a general knowledge of the methods of analysis and synthesis. Such a course must, therefore, necessarily be largely descriptive, and the experimental work largely illustrative. The same course is frequently given to the electrical engineer as to the first few terms of the chemistry student: general inorganic chemistry of the most important elements, and qualitative analysis. While a first-class beginning of a course of chemistry, such a course leaves the engineer with a knowledge altogether too fragmentary to be of benefit to him, and the time spent in mastering the mechanism and the details of qualitative analysis is largely wasted, since the electrical engineer will probably never be called upon to make an analysis. If he attempted to do so he would probably fail. The beginning of a chemist's training is not suited to the chemical training of the electrical engineer, and the same applies to all other sciences to which a limited time is devoted in the electrical engineering curriculum. To give a general view and working knowledge to the electrical engineer of such an allied branch of science, theoretical discussions, especially mathematical, are usually very little needed and therefore undesirable. A characteristic case of spoiling a science to the student by mathematics is that of astronomy. Astronomy is one of the most interesting and fascinating of subjects. But where taught as a part of the general educational program, it frequently is all mathematics, and so hopelessly dry and repellent. It should be given descriptively, for in a short course on astronomy it is just as ridiculous to delve deeply into mathematics as it would be to start the teaching of geography with a course in spherical trigonometry. I believe that in the teaching of allied sciences our colleges and schools are still greatly inferior to those abroad; the result is very marked in the product of the colleges, in the inferiority of the general education possessed by our graduates.

It goes without saying that in all teaching the strongest endeavor should be made to correlate the different subjects, to show the students the close relations which exist between all the branches of science, no matter how different they appear at first sight; and to interest him by bringing home to him the practical importance of what otherwise would appear dry theory. For instance, by using in the teaching of mathematics, problems taken from engineering; to have him handle and operate machines before proceeding to their theoretical investigation; then to derive the constants of the theoretical investigation from experimental tests of the apparatus; and from these predetermine the performance of the

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apparatus under different normal and abnormal conditions and experimentally verify it.

In conclusion, the main defects in the present electrical engineering training in some of our colleges appear to me as follows:

1. The insufficient remuneration of the teachers, which makes most of the best men unavailable for educational purposes and is, therefore, largely responsible for the other defects.

2. The competition between colleges, which leads to a curriculum marked more by the quantity of the subjects taught than by the thoroughness of the teaching. The graduates are sent out with a mass of half understood and undigested subjects, quickly forgotten, and deficient in understanding of the fundamental principles and in the ability to think.

3. The tendency of some colleges to teach the trade of electrical engineering rather than educate intelligent and resourceful electrical engineers.

4. The unsatisfactory state of the teaching of allied sciences, which gives instead of general view and understanding of the science, a fragmentary knowledge of some details.—*Read before the American Inst of Electrical Engineers, Jan. 24.*

The Value of "Gumption"

A central station engineer has to be more a man that has his wits about him than a gentleman of highly technical knowledge. This statement may sound rather revolutionary, but practical experience has shown that in many cases men who have had the highest advantages in technical college training, and who have distinguished themselves in examination results won from sheer book work, have proved utter failures when transferred to the rough and tumble of central station life. On the other hand, men who have worked their way up from the ranks, even from greasers or stokers, have many a time saved a central station from disaster by means of their mother wit. No disrespect is intended in these remarks to technical education—which is of considerable value, but the point to be impressed is that book learning can be given about twenty points out of a possible hundred in the valuable make up of a station engineer. The remaining eighty points can be about equally divided between coolness and resource.

A very interesting example of the way in which high science may be led astray by the absence of a little common logic was brought to the writer's attention a short while ago. A battery of slow running pumps was in use for the purpose of delivering very hot water from the hot well to the boilers. For some time, owing to the smallness of the load on the station, the battery worked quite well, as it was only required to run at slow speed. Directly, however, the station load began to rise and the pumps were put away at anything like their full duty, hammering began in a most marked manner.

The first thing that was done was to carefully overhaul the valves of the pumps. There was nothing wrong with these. Then a considerable amount of theorizing was done as to the probable effect of disengaging steam from the hot well water causing irregular pumping action and the consequent banging of the pistons. The makers of the pumps were written to and skilled representatives were sent down in order to put the pumps right. After taking off all bolts, setting everything to gauge and template, and putting the parts back into place, the pumps were again started away with the result that the banging again occurred as soon as the pumps were brought up to their full duty.

The supply authority was just on the point of going to the expense of putting in very large air vessels on both the suction and delivery side of the pumps in order to get rid of the supposed effect of the steam evolved from the hot water, and were in the meantime running six pumps where four would do in order to escape the trouble, when one of the employees suggested that the trouble might altogether be removed from the pumps. He suggested that the boilers should be set off one by one and the clack valves of the feed in these examined. Although the suggestion was at first ridiculed, it was ultimately adopted, and it was then found that several of the valves were considerably grooved and letting back water and steam pretty badly. As soon as these were put right the pumps were again set away, and it was found that every pump did its duty in a noiseless and easy manner. The whole trouble was due to the heavy back rush of water and steam on the pumps at each stroke, when the strokes were heavy, and the loss of time and money was caused by an insufficiently thorough logical examination of the problem in a practical manner.

Other instances could doubtless be quoted where the absence of cool headed logic has led to serious loss in central station practice, but this is a typical example—*Electricity, London.*

The Thirty-first Convention of the National Electric Light Association will be held in Chicago, May 19th, 20th, 21st and 22nd.

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The Central Station

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The Objective Point in Lighting

The field of electric lighting is so extensive at present that it is rather rash to predict its real objective point. Judgment is very apt to be biased in pointing out what might be termed the ultima thule of lighting, for the obvious reason that each particular department of invention has a distinct objective point. It is an easy matter to rapidly review the situation and draw conclusions from existing conditions as to the real state of affairs.

To begin with, that which is called electric lighting includes historically, at least, lighting by means of an arc, by means of an incandescent filament, and by the use of a gas more or less rarified, or a vapor so affected that it gives a maximum of illumination. The objective point from this limited evolutionary standpoint is not as clear as might be expected. The scientists and inventors who have devoted their time and energies to the development of each of these forms of lighting occupy an entirely distinct position from those whose interest lies entirely in an adaptation of these inventions to commercial purposes.

On the one hand, we have the scientific and engineering phase of the situation presenting itself, and on the other hand that which might be called the purely business point of view. For reasons such as these the objective point of lighting, to the man engaged in the manufacture and sale of light producing devices, is the exploitation of one which will be generally acceptable and incidentally most profitable. The idealistic position is one which hardly exists in a field of open competition, nor can it be said that the instinct which drives on the inventor and scientist to his goal is derived from philanthropic sources. In consequence, of these facts, it may be broadly stated that as far as the public are concerned, either individually or collectively, plenty of cheap light is the most interesting phase the situation presents.

In the construction of arc lamps, three distinct points of invention may be noted: First, the original idea by the crystallization of which two carbons were automatically fed so as to produce a uniform arc; secondly, the invention of a method of surrounding the arc, in a closed globe so constructed as to admit carbons freely, and yet exclude the air, by means of which the life of the carbon rods was greatly increased; and thirdly, the employment of specially prepared carbon rods saturated with a salt solution and cored with a metal which enables the arc to be greatly extended and thereby give much more light.

In the incandescent lamp, at least as far as its original form was concerned, a strange difference of opinion existed between its two noted inventors—Edison and Swan. According to some early records, it is claimed that the dormant idea in Edison's mind was the production of a carbon filament of a fibrous nature, or at least one having grain. On the other hand, Swan is reputed to have attempted the manufacture of a homogeneous filament entirely without grain. When it is considered that both inventions were to serve similar purposes, possess the same functions, produce the same results and be commercially practicable, it is curious to realize that they were coincidentally successful.

Without referring to the vapor or tube light, it

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is well worth noting how objective points in lighting change as new experiences crowd in upon the inventor's mind. The simple accomplishment of the fact, namely, that of producing a lamp with a carbon filament heated to incandescence in a vacuum by means of a current, gave way to a new objective point, that of a filament yielding its light at a high efficiency. The tube or vapor lamp represents quite a different point of view from the others in that its inventors wish to dispense with small units or centers of light, and desire to produce a more diffused effect at what they hope will be a higher efficiency. The fact that in nearly all these fields of lighting the efficiency is gradually rising, and though the methods of producing the light radically differ, a combined effort is being made to produce cheap light, is significant as illustrating an unconscious co-operation. In other words, the situation may be summed up in the statement that progressive reasoning applied to a light producing device, will lead to the ultimate conclusion that cheap light, that is to say, highly efficient illumination, is the desired objective point. In this respect it is easy to anticipate the result which the years will bring. The sources of electricity will receive unquestioned benefit from every new stage of development presented by the electric light. A new electric light of extremely high efficiency would be the means of enabling central stations to greatly increase their zone of operation, offer greater advantages to the consumer, and add immensely to the popular spread of electricity for lighting. In fact, it seems to be more a question which is up to the inventor and manufacturer than the central station, and for this reason, whatever is new and really advanced in the field of light inventions, possesses more than usual interest for us.

Alternating Current Development and Power Consumption

The remarkable extent to which alternating current practice has spread is coincident with an equally great development in power consumption. The extreme flexibility of a power developing, transmitting or distributing system is entirely due to the use of an alternating current. The use of natural sources of power has been exemplified in the United States, Switzerland, Germany and other countries where otherwise no opportunities could possibly have existed for the development of distant communities in an industrial sense. It is more than obvious that this age is stamped peculiarly and distinctly as one in which machinery rules. The use of human labor has changed to a remarkable degree in that where once it directly performed work which resulted in various grades of development of the product, today, through the aid of machinery, driven by power, work is finished almost at once. For a considerable time steam dominated the industrial field to the practical exclusion of all else. Toward the end of this period explosive engines reached a sufficiently advanced stage of development to play their part in the industrial epoch. The development of the electrical science led to the use of electricity for lighting and power to such an extent that it may be stated conservatively that electricity is successfully vieing with all other forms of energy employed for industrial purposes.

The reason for this successful exploitation of electricity as a source of power industrially, and therefore commercially, is attributable to the increasing use of alternating currents in this country and abroad. The physical advantages of economically transmitting power so that a place formerly unproductive industrially is made productive, perhaps to an extraordinary degree, leaves little to be said as to the reasons why it should not develop on every possible occasion. In other words, statistics would be apt to show a parallel case of alternating current service and power consumption increasing coincidentally. This is not at all surprising, considering the fact that two and three phase currents are utilized for power purposes, the very expression transmission of power applying as much to the electrical energy transmitted as to its ability to produce power at the other end. The reports published at Washington covering these facts indicate a surprising increase in the use of electricity in the United States for power, light and other purposes. The Patent Office also shows a remarkable increase in inventions in the alternating current field. Many of these inventions are of a character which relates directly or indirectly to power purposes. The induction motor, the transformer, the alternating current generator, the insulator for high tension work, and new systems described in detail, show the effects of the vast impetus given to the industry of the sale and use of electricity, by the introduction and spread of alternating current practice.

An examination of various industries shows the degree to which electric power has come to stay as far as its use is concerned. In New England there are many large manufacturing centers which use steam and electrical power to an enormous degree. One of the noticeable features in their development in the last decade has been the introduction of elec-

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tric power and the installation of larger and larger electric equipments for the purpose of effecting economic gains in the operation of the plant. In the iron manufacturing centers electric power has found its way and established itself to such a degree that in many instances its use is almost exclusive. Many silk mills and manufacturers of a variety of things have adopted electricity as the nearest solution of many difficulties which formerly confronted them. This unusual spread of electric power in places where it is held to strict accounting as a matter of profit or loss, aside from convenience, is attributable to the increasing use of electrical energy for transmitting the power, as well as distributing it from distant sources. Even in central station practice it is not considered a case of any importance when the electrical energy is sent quite a few miles away from its point of generation. In other words, we are growing accustomed to electrical zones of increasing diameter to which alternating currents are sent and from which they are distributed either in their original form or reduced to direct.

The conclusion is, therefore, obvious that invention and experience have not been at variance in promulgating this new scheme of electrical development. There is much that industrial experts have to thank the electrician for, and not the least, from a national standpoint, is his prophetic view of the industrial revolution now going on in the substitution of electric power for steam.

The Testing of Insulators

It may not be generally known that the design and construction of insulators is very much of an art and in consequence those which are employed for high tension transmission represent a high degree of intelligence and design in their construction. The transformers employed for testing insulators step-up the pressure to a very high point in order to make a test that will be considered adequate by consulting engineers. For instance, the voltage employed for this purpose runs as high as 200,000 volts and over.

The usual practice, after the insulator has been satisfactorily inspected, is to test, in order to find out what pressure will be required to produce an arc from the surface of the insulator to the pin which supports it. It may be noted, in touching upon this matter, that insulators are designed not only with reference to their durability, but much consideration is given as well to their power of resisting destruction when exposed to the action of an arc. Many of the tests made, in addition to that of actually applying an arc to them, are tried in oil. The insulator is generally placed up-side-down in water, so that its upper edge is free, and an effort made to establish a spark between the stem and the liquid in which it is immersed. It may not seem a difficult matter to attempt this, but builders of well-known insulators will state, without reserve, that they meet with many set-backs in their efforts to produce a strong, reliable insulator which will stand a guarantee.

The fact that a very extensive field of electrical activity depends upon the insulator is sufficient to bring to mind the truth that, after all is said and done, that which is regarded as incidental frequently becomes of prime importance, as in this case. The insulator was considered quite sufficient if it represented insulation, but the use of fifty and sixty thousand volts has given rise to new opinions on the subject. For instance, an insulator that is to be used for 50,000 volts must be tested for two or three times this pressure before it is permitted to pass out of the shop and enter the stock room. The smaller insulators are naturally tested to a much higher point than their actual work calls for, but this is largely due to the fact that their use is found where pressures are much lower. In one instance where a laboratory was established for the testing of insulators, extraordinary precautions were taken to avoid any unnecessary risk to the employee. It must be realized that the high tension current used for testing is one which has the backing of power behind it, thereby rendering it deadly to the human frame. The transformers are rated at one or more kilowatts, and are consequently able to send a very destructive current to the point required.

The realization of the fact that insulators are exposed to rain and snow, and dust and dirt calls for some form of test which is made under conditions partly duplicating these. For instance, a high tension line strung along a mountain side is apt to be affected with dripping moisture, and consequently the insulators, if exposed to a tension of fifty or seventy-five thousand volts, will show a tendency to break down, unless the tests they have undergone show conclusively that they will rise superior to this condition. A well equipped testing laboratory having for its purpose the legitimate exposure of insulators to existing conditions, would necessarily have to be supplied with means for reproducing snow and sleet and vapor effects as well as dust and dirt. The insulator, therefore, is not one which is necessarily

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made of insulating material, and is sufficiently strong to stand the strain imposed on it. The electrical requirements are sufficiently explicit to render it necessary to turn out insulators, if they are to be deemed reliable, which will meet the severe demands of actual practice.

The development of power transmission over long distances is evidently a case pinned down to that of the successful design and construction of acceptable insulators. In other words, the key to the high tension power transmission system is to a considerable extent found in the well made insulator, and on account of this, too much cannot be said of the severe tests to which insulators are exposed before they are ready for the market.

The High Building and Wiring

The tendency to erect tall buildings in all of our large cities has increased greatly in the last few years. In consequence of this, wiring has become one of the important questions to be solved in connection with this architectural phenomenon. The problem, fortunately, is not in any way so difficult that a well trained consulting engineer finds it beyond his powers to solve. The realization that the lighting must show a uniform candle power has become a fixed truth, so that the design of a wiring system or plan for a tall building is generally carried out to a successful culmination. In buildings of five or ten stories the centers of distribution are so arranged that the building is readily lighted without any visible signs of drop. In buildings of ten or twenty stories or more, it is evident that risers or feeders must be designed to suit the implied needs. In other words, the proprietor can ill afford to have the upper floors of his building badly lit and lower floors supplied with light from lamps of normal candle power.

The choice of centers of distribution to which the risers or feeders are wired, and from which the branches radiate to other parts of the building, must be made with the greatest of discretion. A generating plant in the lower floor of a tall building is apt to be forty or fifty feet beneath the sidewalk, so that the care taken in calculating the circular mils of conductors must be made with an eye to the final pressure delivered. Perhaps one of the dangers which central station managers ran in the past more than the present was deficient wiring in tall buildings. When current was turned on, the light effects were bad, and the pinning-down of the responsibility to the contractor was not only difficult, but at times unconvincing to the proprietor. The panel boards now employed, to which the main conductors run and from which the sub-wires radiate, have greatly helped to clear away many difficulties.

In very tall buildings, one or more floors are regarded as a unit for lighting in the sense that a certain set of conductors are employed running from the engine room to the panel board entirely for the purpose of lighting them and none other. The subdivision of a tall building in this manner into sections for lighting means that each floor or group of floors so selected represent a separate wiring proposition in themselves. The drop is, therefore, calculated, from the generator to these floors in each separate instance, and it is therefore not surprising in the end to note the excellent results obtained, due not only to the system followed, but the remarkably well constructed devices in use in this respect.

FORMS OF PROTECTION FOR CENTRAL STATIONS.

The investment represented by a large central station frequently runs into seven figures, this being at least one of the reasons why the question of protection in certain instances is vitally important. The conditions of service presenting themselves in the case of a large central station, though varied, may be generally grouped into the three familiar classes of electricity for light, for power and for heat. It is evident to even the lay observer that complications must necessarily arise in such an instance: one, it might be said, in which thousands of people are obtaining energy from a central source and utilizing it in ways that give rise to short circuits and grounds. Accident is, of course, the dominant feature in all cases where a central station needs absolute protection. The protection which is found in the use of circuit breakers is due to conditions which give rise as much to an overload as a short circuit. Therefore, the protection of a central station against overload and short circuit is fundamentally necessary for two reasons: First, the continuance of the service and secondly, the protection of the station building itself.

The vast amount of money saved by the use of an efficient and reliable circuit breaker cannot be lightly estimated. In looking over the past records of electric lighting, many instances will be found where the blowing of large fuses gave rise to painful burns and injuries which dynamo attendants were subject to. It is easy to realize that in those cases where thousands of amperes are to be considered, the use of a fuse and its volatilization would amount to a catastrophe. On the other hand, a very large fuse

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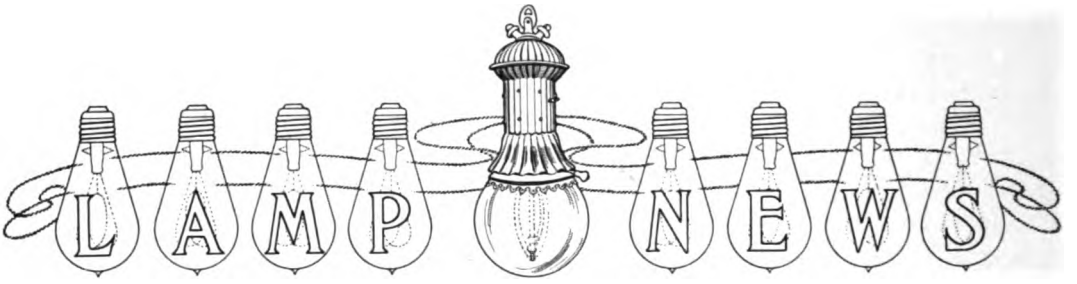
would be doubtful as to its absolute point of melting and in consequence, as necessity is always the mother of invention, the exigencies arising from new conditions force the issue in the form of a circuit breaker.

The elimination of this hitherto unknown piece of apparatus would be a calamity to all stations dependent upon it for their protection. The development it has undergone and the remarkable degree of reliability to be placed upon it, give it a position in a central station second only to the generator itself. The spread of electric lighting throughout the country, and the increasing use of electricity for power, have led to the manufacture of very large circuit breakers. In street railway service they also appear in a highly developed form and of large capacity. In places where power transmission prevails, they are installed with an added feature which gives them the title of reverse current circuit breakers, as described in an article in these columns. The central station power house and transmission plant are today wholly dependent upon the circuit breaker for their primary freedom from immediate risk due to short circuits and overloads. Estimating on this basis, it is readily seen that the property and lines protected by devices of this character would run into figures representing some hundreds of millions of capital. The degree of protection thus exercised carries a moral which is obvious to any intelligent reader.



The Tungsten Electric Lamp Company

The day has arrived for the relinquishing of the absolute control of the electric incandescent lighting field by the carbon lamp. This illuminant which for many years has reigned supreme, as a small unit, with only a few changes taking place in its make-up, must now give way in the majority of places to metal filament lamps, among which is found the Tungsten.

The success of the Tungsten lamp is apparently assured beyond the least possibility of doubt. Sixteen of the prominent lamp manufacturers in the United States have shown their faith in this new illuminant by having founded The Tungsten Electric Lamp Company on October 29, 1907, under the laws of the State of Ohio, with a capital of $100,000. The incorporators are as follows: Messrs. G. G. Lockwood, A. C. Garrison, H. B. Vanzwoll, A. S. Terry, L. P. Sawyer, H. H. Geary, J. C. Fish, H. C. Rice, E. H. Haughton, E. W. Gillmer, J. B. Estabrook, W. D. Packard, William Coale, E. J. Kulas, J. E. Randall and T. W. Frech, Jr.

It is needless to say that the gentlemen, whose names have just been given, did not place their money in this new enterprise until they had thoroughly investigated the proposition.

Mr. T. W. Frech, Jr., and Mr. J. E. Randall, President and Vice-President, respectively, of the company, are so well-known in the lamp manufacturing industry that they hardly need an introduction. The former has, in days gone by, had charge of practically every department in a lamp factory, advancing step by step to the positions of superintendent, manager and supervising manager. There is absolutely no operation entering into the production of electric incandescent illuminants which he does not thoroughly understand and cannot perform. Mr. Frech has given up all other interests to manage The Tungsten Electric Lamp Company and superintend the factory. Mr. Randall started in the lamp business over twenty years ago. In 1886 he was in the employ of the Thompson-Houston Company in Lynn, Mass., as a lamp engineer. He has made a

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study of the business ever since from the engineering side, specializing in research work, experimenting, testing and naturally improving lamps by determining causes of trouble and method of illuminating same. Mr. Randall's work will continue along these lines in the future, his entire attention being given to the Tungsten lamp.

Both Mr. Frech and Mr. Randall have spent much time abroad during the past three years. The purpose of the numerous trips, which they have made to the other side, was to carefully study the metal filament question by investigating the laboratory work the first to find the possibilities of Tungsten as an illuminant and to study and criticize the manufacturing methods employed in producing this new lamp in foreign countries.

After many experiments of their own and discussions with the parties who are now stockholders in the company, Messrs. Frech and Randall, finally satisfied that they had brought Tungsten to the point where, viewed from all sides, it would in many in stances be found superior to other filaments, had the company incorporated.

Messrs. Frech and Randall naturally call at times upon the experienced men who are interested financially with them.

The factory of The Tungsten Electric Lamp Company is located in Cleveland, Ohio. It is concrete and fireproof throughout. There are four stories and the basement, which allow a total floor area of approximately 30,000 square feet, the building being 55 x 112 feet. The capacity at the present time is not over 2,000,000 lamps per year, but can be increased.

The lamps are now manufactured in 40 and 60 watt multiple and 4, 5.5, 6.6 and 7.5 amp. street series, with a total wattage of 40, 50 and 75 watts, sizes. The mean horizontal candle power of all these illuminants is 1.25 w.p.c.

The chief characteristics of the Tungsten lamp is its comparatively low consumption of energy and the extremely white quality of light which resembles that of the sun.

Tungsten Series Incandescent Lamps

The city of Grosse Point, Mich., has recently installed a series Tungsten incandescent street lighting system, where the advantages of this kind of lighting are well exemplified. The station equipment consists of two 8.8 kw. 5½-ampere constant current transformers. One of these is held in reserve, while the other supplies current to seventy-seven 60 c.p. General Electric tungsten series incandescent lamps, suspended from artistic iron poles. All wiring is laid in conduits to the poles and wires pass up the

FIG. 1.

center of the pole to the lamps. The form of poles used not only gives a very substantial line construction but makes a much more artistic appearance than

FIG. 2.

the usual wooden pole. These poles and lamps are shown in Figs. 1 and 2.

One of the interesting features of this system is the radial reflector with which the lamps are equipped. This form of reflector, which was recently developed by the General Electric Company,

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is so constructed that the light is spread and projected very evenly over considerable area instead of being nearly all concentrated in a circle around the lamp. Fig. 3 shows the candle power distribution of a 40 c.p. series Tungsten lamp equipped with a radial reflector. It may be seen from the diagram of the candle power distribution that at about 30 degrees below horizontal the effective illumination is 50 candle power, making the efficiency at this point about 1 watt per candle power.

The series sockets with which these lamps are provided are so constructed that when a lamp is removed from the socket two contact plates of large area close together before the lamp is quite drawn out of the socket, leaving no danger of an open circuit at any time.

foliage makes it necessary to have the units distributed at short intervals to produce satisfactory illumination.

At the Chicago Electrical Show, held at the Coliseum, January 13 to 25, the M. B. Austin & Co. booth was lighted by G. I. Tungsten lamps giving 50 candle power and consuming 60 watts. Huge placards called attention to this fact and the booth was constantly thronged with enthusiastic electric lighting people. Orders were taken by this company for hundreds of Tungsten lamps, mostly for small quantities for trial purposes.

The "G. I." Tungsten lamp is made in Cleveland,

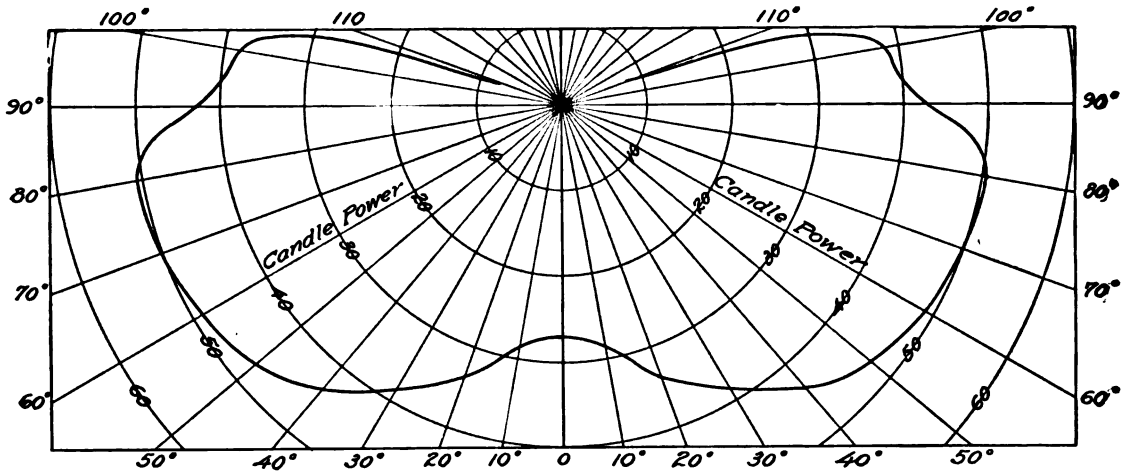

FIG. 3.—CANDLE-POWER DISTRIBUTION OF A 40 C.P. SERIES TUNGSTEN LAMP EQUIPPED WITH A RADIAL REFLECTOR.

Tungsten series lamps are made in 32, 40 and 60 c. p. sizes with current ratings of 4, 5.5, 6.6 and 7.5 amperes and are exceedingly hardy on account of the heavy short filament. They will burn for nearly 1,000 hours at efficiency of from 1¼ to 1½ watts per candle power.

Another installation of series tungsten lamps for street lighting has recently been made in Grand Rapids, Mich. The lamps are of 60 c.p. and were placed on one of the principal streets of the city. Judging from the complimentary remarks of the press and the city council, the test installation has proved highly satisfactory.

The tungsten lamps with its high efficiency should greatly increase the use of series incandescent lights in suburban and residential districts where the thick

Ohio, by The General Incandescent Lamp Company, located at 1811 East Forty-fifth Street. This is one of the most enthusiastic companies in the business and the men who are making the "G. I." Tungsten lamp went to Europe on purpose to learn the German methods of working this wonderful metal so as to give the highest efficiency, the longest life and also for them to obtain in their lamp the best workmanship. At the present time these lamps can be furnished in two sizes, *i.e.*, 32 c.p., 40 watts, and 50 c.p., 60 watts, approximately, or an equivalent in current consumption to the present day 10 c.p. and 16 c.p. incandescent carbon filament lamps. This company is now prepared to furnish these lamps in packages of sixteen (16) for trial at $1.50 and $1.75 respectively, f.o.b. Cleveland, O.

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It is learned that the Westinghouse Lamp Company, manufacturers of incandescent electric lamps, and one of the constituent companies of the Westinghouse Electric & Manufacturing Company, have obtained the signatures of 99% in amount of the creditors to the readjustment plan permitting a discharge of the receivership. The receivers have found the company's financial condition to be entirely sound, the assets being approximately five times as great as its liabilities. The formalities connected with the application to the court, for a discharge of the receivers are now under way, and it is expected that the company will be returned to its shareholders by the first of March. The business of the company has continued without interruption during the receivership.

The officials of the company are expecting to have the new plant at Bloomfield, New Jersey, in operation before the end of the summer. It will have a capacity of over 15,000,000 lamps per year.

The new factory of the Brilliant Electric Company, of Cleveland, Ohio, which is situated at Conneaut, Ohio, has an annual output capacity of five million lamps. This new factory is very advantageously located, being on both the Lake Shore and Michigan Southern Railway and the New York, Chicago and St. Louis Railway, as well as having excellent lake shipping facilities from Conneaut Harbor. The buildling is of brick and iron construction, three stories in height, with a total floor area of forty thousand square feet. The top floor of this new factory, on which most of the lamp making is done, is a very light room without a single partition or post to obstruct. Mr. H. F. Schadel, who has had twenty-five years of experience in the lamp business, is superintendent of the factory, and Mr. E. J. Kulas is the general manager and secretary.

The Rooney Electric Lamp Company, of New York City, is now placing on the market a new turn-down lamp, which is already meeting with marked success. The base of this new lamp is a permanent fixture from which a small chain suspends and by a single pull a bright light or a dim light may be attained, and an additional pull extinguishes the light. This new base is practically indestructible, and may be used for an indefinite number of bulbs which are furnished at a comparatively slight cost. This company is publishing an illustrated circular regarding the Rooney Turn-Down lamp, which will be sent to any one on application.

The Shelby Electric Company, of Shelby, Ohio, reports that Mr. T. Fred Lee, the New England representative of the company, who has been confined to his bed with typhoid fever, has fully recovered and has been regularly at his office since January 1. Mr. J. W. Cushman, formerly with the Toledo Lighting Company, will represent the Shelby Electric Company in Western Pennsylvania, and commence his duties on February 1. The above company has recently put on the market a new street railway lamp, in which the filament is strongly anchored to withstand any vibration.

The Sunbeam Incandescent Lamp Company, of New York and Chicago, wish to call the attention of the Central Station Managers to the Sunbeam Tungsten Lamp which they are now ready to place on the market.

These lamps, giving a light which is the nearest approach to daylight, are particularly adapted for use in places where it is necessary to secure true color values, and being made in commercial candle powers—32 and 50, the central station managers will be able to place these lamps readily in the various dry goods stores, jewelry shops and other similar places where the ability to match colors perfectly by their use will appeal to the store owners.

Mr. H. J. Jaeger, President of the Tipless Lamp Company, of New York City, reports a rapidly increasing business for his product on the Pacific Coast, and shipments are being made every day to the San Francisco offices and stock rooms, which are situated on the corner of Bush and Market Streets. Mr. George T. Bryant is the manager of the San Francisco office, from which all orders for the Pacific Coast are handled. The new Jaeger Tipless metallic filament, 2½-watt lamp will soon be on the market in 20 and 40 candle power sizes. This new type of lamp is soon to be followed by the Jaeger Tungsten lamp.

Mr. H. M. Lauritzen, of the Engineering Department, Holophane Company, is in the West, chiefly in the interest of his company, but partly, also, to recuperate from recent illness. Mr. Lauritzen will remain probably several months in Flagstaff, Ariz., returning to New York via Mexico City, where he will assist the Holophane Company's local representatives, Messrs. Victor M. Braschi & Co., in handling a number of important lighting installations.

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Mr. H. H. Geary, Sales Manager of the Fostoria Incandescent Lamp Company, of Fostoria, Ohio, states that the big increase of business of his company during the month of January, and the placing of large orders by jobbers to replenish their stocks, is the best indication of a rapidly improving business situation throughout the country.

Mr. Oscar C. Turner has resigned his position as Manager of the Southern Electrical Co., of Nashville, Tenn., and has accepted a position with The Warren Electric & Specialty Co., of Warren, O.

Mr. Turner has a host of warm friends who will wish him success in his new position.

Germania Electric Lamp Company, of Newark, N. J., have recently issued a very interesting and instructive catalog consisting of thirty-one pages, and filled with half-tone cuts of their various types of lamps which are made for all the standard voltages and candle powers. Germania Reflector Lamps are also illustrated in this catalog, and light distribution curves are given for both the clear and frosted types which are made in 4, 8, 16 and 32 candle power, and by the use of a coating of silver on the top half of the lamp, show a tip candle power of 20, 35, 75 and 175, respectively. This catalog will be sent to any central station manager upon request.

Mr. H. A. Baum, Secretary of the Safety Electric Company, of Chicago, Ill., reports a rapidly increasing business for their new refilled incandescent lamps, which company is also a large purchaser of burned-out lamps.

Enclosed Arc Lamps for Photo-Engraving, Photographing and Blue Printing

The Adams-Bagnall Electric Company, of Cleveland, Ohio, are manufacturing an enclosed arc lamp designed to meet the requirements of the photo-engraver, the photographer and the blue-printer. This lamp may be had for either direct or alternating current, 110 or 220 volts. It is of especial interest to central stations, as its use is becoming general among up-to-date photo-engravers, photographers, architects, engineers, etc., and thus affords a new avenue for the disposal of power.

In its design and construction, the manufacturers have carefully considered the conditions under which the lamp is to operate. Each lamp is provided with an external controller, which enables the operator to obtain a steady light, notwithstanding a variation in voltage. Its simplicity in construction and reliability in operation have appealed to those

interested in artificial illumination for photo-engraving, photographing and blue-printing.

The above company are about to issue several new bulletins. These will be descriptive of their various types of "A-B" lamps. One will be con-

fined to the "A-B" series arc switchboards. Their new bulletin on the "A-B" A.C. series arc system will appear especially to those interested in an A.C. series system of especial merit.

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The general offices of this company are located at Cleveland, Ohio, and district sales offices are maintained at New York, Philadelphia, Chicago, Atlanta and Scranton, Pa.

Series Luminous Arc Rectifier System

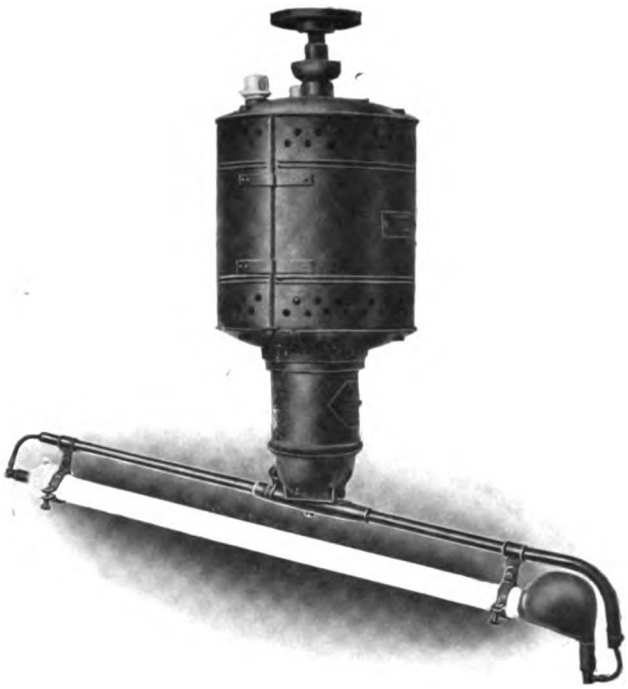
The Series Luminous Arc Rectifier System developed by the General Electric Company, Schenectady, N. Y., permits the operation of direct-current luminous arc lamps from alternating current central stations at high economy and with extreme simplicity, and is described in Bulletin No. 4556, recently issued. The General Electric luminous arc lamp and the auxiliary apparatus consisting of oil cooled rectifier tube, constant current transformers and switchboard panels with the necessary control apparatus, reactance coils, etc., are described and their operation explained. In the General Electric luminous arc lamp the upper electrode is a bar of hard drawn copper, and the lower electrode is made of specially prepared composition contained in an iron tube 5/8 of an inch in diameter by 8 inches long. This lamp is claimed to be superior to other commercial lamps, in efficiency, distribution of light, color of light and low maintenance cost, and is particularly well suited to street lighting. The light is as white as any artificial light in commercial service today and it has a spectrum which is practically the same as that of sunlight. The standard switchboard sets are designed for 12, 25, 50 and 100 lights, and include all the necessary apparatus, such as ammeter, plug switches for operating the different circuits, indicating lamp, starting switch, etc. One of the main advantages of the system is its adaptability to circuits of any frequency from 25 to 100 cycles. A partial list of equipments furnished by the General Electric Company gives an aggregate of over 12,000 lamps already installed.

A New Cooper Hewitt Lamp

The 1908 Model of the Cooper Hewitt Lamp has a number of improvements which add much to the commercial value of the lamp. The Cooper Hewitt Electric Company, New York, are the sole manufacturers of Mercury Vapor Lamps, and have incorporated in the new model several mechanical and electrical improvements as a result of their experience during the last five years.

The general form of the tubes of the several types of lamps remains the same, together with the quality and the high efficiency of the light. The improvements made in the new 1908 lamps are for the most part, in the auxiliary and the method of installation. The new design makes it possible to handle each lamp outfit as a unit, and has greatly simplified the hanging of the lamp.

The parts and functions of the auxiliary to the lamp tube remain the same, and the changes are along the lines of improvements in the manufacture and the assembling of the auxiliary. The new cas-



ing of the auxiliary resembles in a way the housing of an arc; being cylindrical in form and about eight inches in diameter and ten inches high, with the supply lines entering binding posts at the top. The cover is hinged and may be thrown back, furnishing ready access to the parts of the auxiliary. The lamp rod which supports the tube, is attached directly to the auxiliary by a pivot screw.

The hanging and connecting of the new lamp is extremely simple. A ceiling plate, a short threaded pipe nipple, and an insulating joint are furnished with each lamp outfit. These are fastened to the ceiling, and the auxiliary screwed to the insulating joint. Where it is necessary to hang the lamp at some distance from the ceiling, a pipe or conduit of the proper length can be used between the plate and

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the auxiliary. Where lamps are hung from outlet boxes the ceiling plate can be dispensed with. When desired the lamp may be hung from a wire rope by screwing a hook to the insulating joint and properly guying the lamp so that it will not swing.

The performance of the Cooper Hewitt Mercury Vapor Lamp depends directly upon the auxiliary. In the new auxiliary the number of parts has been reduced and the design and manufacture of the same improved. The new parts are readily replaced or repaired. The ballast or adjuster is made with a standard plugbase, and screwed into an Edison socket. The inductance coils are thoroughly insulated, and the resistance is entirely embedded in an enamel coated spool which protects the wire against the deterioration effects of gases and dampness. The resistance spool has two binding posts so that the lamp may be adjusted to the actual voltage of the supply. All standard Cooper Hewitt lamps are made for either 110 or 220 volts; the resistance spool just described, furnishes what little adjustment is necessary in the particular group for which the lamp is intended.

Close regulation of the supply voltage is not necessary to the successful performance of the lamp, as the ballast and the inductance coil compensate for ordinary fluctuations. Standard series lamps are operating satisfactorily on power circuits of 500 to 600 volts.

The Cooper Hewitt Lamp is now much used throughout the field of industrial lighting. In this field the scope and number of installations has greatly increased during 1907. During the latter part of 1907 a number of the new Mercury Vapor Lamps were put out. Their performance fully repaid the efforts of the manufacturers in perfecting the operation of the Cooper Hewitt Lamp.

The Excello Arc Lamp Company, of New York City, has recently received a large order for Excello Flaming Arc Lamps from the United States Department of the Interior, for use on Ellis Island, New York Harbor. These lamps will be used for both outdoor and indoor service, and are of the Excello Snow-ball type, which produces a pure white light of very high candle power. This latest order was the result of the satisfaction given by a few lamps of this style which have been used on Ellis Island for some time. The above company has opened a depot in the Electrical Building, Nos. 116-132 West Jackson Boulevard, Chicago, for the convenience of the Western trade. Mr. George W. Armstrong, who has been the Western traveling representative of the company for the past two years, will be in charge of this branch, and will carry in stock at all times, for rush orders, a supply of lamps, carbons, globes and all other accessories and parts.

Felix Hamburger, of 78 Fifth Avenue, New York, importer of arc lamps, is meeting with big success with the new type of "Radiante" arc lamps, on account of their great brilliancy and steadiness of light. The "Radiante" lamps are regularly adjusted for five amperes, but can be adjusted for various currents down to three amperes. The five ampere lamps go from 1,000 to 1,200 c.p. each, and burn for twenty-four hours on one trimming, while the four or 3½ ampere lamps have a life of thirty hours. Mr. Hamburger claims that his 3½ ampere lamp gives as much light as an ordinary 5 ampere arc lamp, and the pure white quality of the light makes it especially valuable for color work. The Robert Gair Company, of Brooklyn, has found this lamp especially adapted to its factory, having tested the quality of light of about twenty-five other makes. Mr. Hamburger is also the United States representative of the Bergmann Electrical Works, and is now handling their make of Tungsten lamps of 100 Hefner candle power, in both the pear and ball shapes, in addition to their regular 32 and 50 c.p. types.

The writer of "Electrical Notes" in the *Times Engineering Supplement,* blames the metallic-filament lamp, with its decreased current consumption, for the present stagnation among supply authorities in the matter of much-needed extensions of plant. "There appears," says our contemporary, "to be a general indisposition on the part of local supply authorities, to extend their generating plant and mains, notwithstanding that in many cases the existing machinery is notoriously inadequate to meet the normal rate of increased demand in the early future. There are numerous towns in which the circumstances call for reorganization of plant; for example, the erection of three-phase alternators for power purposes, supplementing the direct-current machinery installed merely for the sake of the lighting business. But various methods are being adopted to put off heavy capital expenditure. In several cases engineers threatened with deficiency of plant, but unable to obtain sanction for bold extensions, have been obliged to invite manufacturers to suggest

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how they can most usefully fill the narrow space left in their power houses, either with or without rearrangement of the old machines."

"One reason of this tendency to delay is, undoubtedly, to be found in the increasing sale of metallic-filament lamps. With the carbon filament in general disuse it will only require about one-quarter of the present amount of current to supply the same number of public and private incandescent lamps. Financial crisis will be averted by the advance of the price per unit to the limit of 7d., allowed by the Board of Trade, which is almost double the present general average, by the immediate supercession of the many thousands of street gas lamps, and by the more vigorous development of power business." Whilst there is, doubtless, a modicum of truth in this allegation against the metallic-filament lamp, it is hardly fair to saddle it unreservedly with the full responsibility for this lack of enterprise on the part of municipal electricity committees. The metallic-filament lamp is slowly, but surely, securing for electric light that measure of popularity which the incandescent mantle has already brought to the gas interests, both innovations aiming at a reduction of the cost to the consumer without any corresponding diminution, but rather increase, in the quality of the illumination provided.

Any economy effected in the consumption of such necessaries as gas and electrical energy, whilst it undoubtedly militates, at the outset, against the sales of such, and, for the time being, is bound to reduce the demand, nevertheless reacts favorably later, when the cheapening begins to have its effect upon the public, by inducing more of them to become consumers. Now, then, is the time for generating-station managers to look to their plant, and see that it is equal to the demand which will, unquestionably, be made upon it so soon as the public realize the large economies effected by the introduction of metallic-filament lamps. As I have already pointed out, the reign of the latter has only just begun, and we are at the beginning of an epoch in the electric lighting industry which will mark the gradual, if not absolute, disappearance of the carbon-filament.

Lectures on Illumination.

Members of the Engineering Department of the Holophane Company will be open this year, as last, to a limited number of engagements for lectures on Illumination. These illustrated lectures have created wide interest among the electric and gas companies, for the benefit of whose solicitors and customers they are generally given. They are in no sense lectures on the prismatic system of lighting, but treat the fundamental principles of illumination broadly, combining primary instruction in the practical engineering of light with non-technical expositions of good and bad practice of the art.

The number of lectures given last season were as follows: Mr. Lansingh 21, Mr. Lauritzen 8, and Mr. Marshall 69, the latter speaking in all of the principal cities of the central and western states, in a tour which lasted over nine months.

Mr. Marshall's work in this department was particularly notable. In his nine months' tour, he traveled over 28,000 miles, gave 69 lectures and addressed approximately 17,000 people. Each lecture was given under the auspices of the local gas or electric company of the city visited, and was widely advertised in the newspapers by write-ups and display advertising, the latter not infrequently running from one-quarter to a full-page and continuing several days previous to Mr. Marshall's arrival. Announcements or special invitations also were sent to technical societies, architects, gas and electrical engineers, merchants, window trimmers, and others whom the lighting company deemed interested.

The lectures were without exception successful in focusing popular attention upon the importance of this subject. They were invariably well attended by people whom it was desirable to interest. The greatest practical result of the lectures, however, lay in the more or less informal after-meetings with the commercial men and solicitors of the several companies. These would crowd around Mr. Marshall, displaying an eagerness and desire for additional information which was eloquent testimony of the deep interest they felt. Not infrequently arrangements were made for private talks with the solicitors, these talks being in the nature of practical lessons in illuminating engineering, continuing several days. On a number of occasions, also, Mr. Marshall was called upon to act in his capacity of consulting illuminating engineer for the lighting company.

This branch of the Holophane Company's activities is a distinct departure in educational work along the lines of illuminating engineering. It is undertaken, not as a source of revenue, but to assist those most vitally interested—the lighting companies—in bringing forcibly to the attention of their customers and salesmen the importance and mutual advantage of good illumination.

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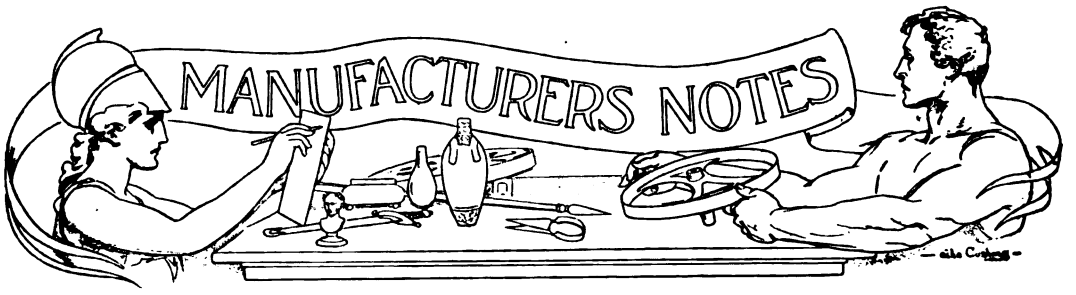

The Westinghouse Companies' Publishing Department has just issued for the Westinghouse Electric and Manufacturing Company Circular No. 1137 on integrating watt meters, which is one of the most complete and instructve publications ever gotten out on the subject of meters. This circular consists of fifty-four pages, and illustrates and describes fully by half-tone illustrations, diagrams and curves, the method of construction and installation of the above company's complete line of integrating wattmeters for single-phase and poly-phase alternating current circuits, and for direct current circuits.

The Murray Iron Works Co., of Burlington, Ia., builders of Corliss engines, pumping engines, boilers and feed water heaters, and who make a specialty of installing complete power plants for every service, have just issued a new bulletin, entitled, "Nomenclature of Murray-Corliss Engines." This new bulletin illustrates by half-tones and diagrams every feature of the standard Murray-Corliss engine, as well as their heavy duty rolling mill type of engine, being a most complete guide to the users of these engines, as every part is shown in diagram and properly lettered. The bulletin also contains half-tone cuts showing the enormous machine shops and foundries of their Burlington works.

Dunton & Field, of Cambridge, Mass., have had ample opportunity during the past year, to test the efficiency and wearing qualities of the Dunton tree insulator, which the above company manufactures, and which is illustrated in the accompanying cut. This insulator is now looked upon by central station managers as the one article that can be depended on for this class of work, and although there are thousands of them in use throughout New England, not a single complaint has been registered against them. During a very severe gale last month, in which the velocity of the wind registered seventy miles an hour, not a single insulator came down, nor were the circuits which they supported interfered with in the least, as the swing of the limbs of the trees was taken care of by these insulators.

D. Van Nostrand Co., publishers, of New York City, now have ready for delivery the fifth edition of Foster's Electrical Engineers' Pocket Book, completely revised and enlarged.

This book has met with tremendous success and is unquestionably the best and most complete work of its kind ever produced. It is a book that no central station man can afford to be without. It is handsomely bound in flexible leather and consists of 1,150 pages and of convenient size for the pocket.

Dossert Solderless Terminal Lugs are used throughout on all the lighting and power panels as well as the switchboards installed in the new eleven-story fireproof Joseph J. Little printing building, 22nd street, near 1st avenue, New York, by E. C. Tibbals & Company.

"Lifting Magnets and Recent Improvements in Them," is the title of a little booklet just issued by the Cutler-Hammer Clutch Co., of Milwaukee, makers of lifting magnets and magnetic clutches. The subject matter of this booklet originally appeared in *Cassier's Magazine*, for October, 1907, which is now out of print.

This little booklet, which is printed in the form of a miniature magazine, traces briefly the development of the lifting magnet, illustrates the different kinds of magnets used for handling pig iron, metal plates and other classes of material and explains, by an easily understood analogy, how the magnetic "lines of force" support weights ranging from and to ten tons. Copies may be had free by addressing the Cutler-Hammer Clutch Co., Milwaukee, Wis.

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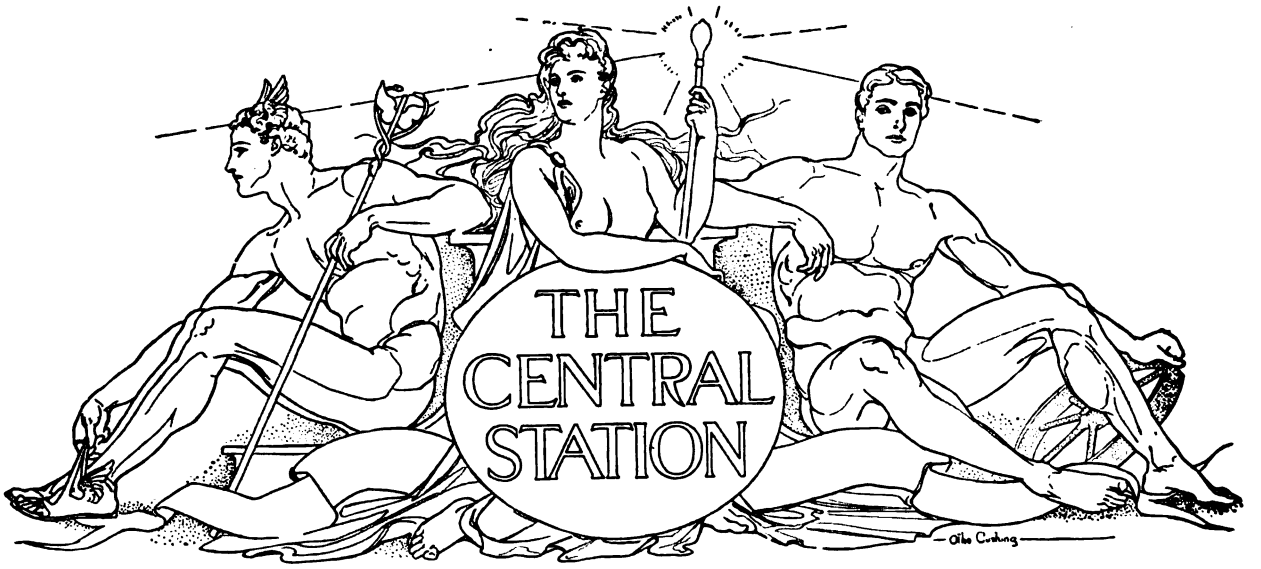

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, NO. 9. NEW YORK, MARCH, 1908. ISSUED MONTHLY.

Central Station Light, Heat, and Power Principles

BY NEWTON HARRISON.

High Tension Circuit Breakers.—The peculiar function of a circuit breaker renders it unique in the particular service it provides at an opportune moment. Whereas this service is easily rendered, with a low potential current, it becomes difficult to break circuits carrying pressures of thousands of volts without incurring grave risks.

The engineering situation is one involving not only a consideration of these risks, but the employment of means in the shape of an adequate device, by which such risk is reduced to its lowest terms.

The pressures broken by means of circuit breakers range from the 115 volts of a lighting circuit to the following:

1. Circuit breaker for 115 volts lighting circuit.
2. Circuit breaker for 500 volts power circuit.
3. Circuit breaker for 600 volts railway circuit.
4. Circuit breaker for 2,000 volts alternating circuit.
5. Circuit breaker for 60,000 volts alternating circuit.

The last proposition is naturally one related directly to power transmission. The pressure indicated can only be safely broken by a circuit-breaker designed to meet such severe conditions. The conditions governing such a design are severe for the simple reason that experience and the best judgment are necessary to obtain results not accompanied by grave personal risks and the danger of fire.

Conditions of Design of Circuit Breaker.—The correct design of a circuit breaker is best obtained by reference to the conditions of service to which it is exposed.

In general it may be stated that the conditions are as follows:

1. Sensitiveness to the set point of load.
2. Rapidity of action in operation.
3. No destructive flash when breaking.
4. Contacts which wear well in service.
5. Large cross sections suitable to current.
6. Springs not traversed by current.
7. Simplicity in construction.
8. Adjustable within reasonable limits.

Other features might be noted and added to this list, but they would not affect the general scheme

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to any great extent. The two fundamental features being quick action, and no destructiveness attending the ruptured circuit.

High and Low Tension Circuit Breakers.—The natural division of circuit breakers into high and low tension types, shows the difference in design necessary to meet the pressure conditions in each case. The real division would be that of circuit-breakers into high, low and medium pressure breakers. For instance, they may be classed as follows:

1st. Circuit breakers of from 120 to 2,000 volts.

2nd. Circuit breakers of from 2,000 to 6,000 volts.

3rd. Circuit breakers of from 6,000 to 60,000 volts.

The class of circuit breakers termed high tension oil circuit breakers are actually designed to meet conditions affecting pressures of from 45,000 to 60,000 volts. The extreme conditions of overload and short circuit are those met with and successfully handled by devices of this class.

Conditions and Causes of Overload.—Without it being necessary to enter deeply into an analysis of causes which lead to overload in central station or power transmission service, it may be stated that the demand upon a particular generator, due to the break down of the other or others in the station, calls for the readjustment of the breaker at once. Otherwise the action of the circuit breaker may be attributed to overload due to the demand for current through increase of consumption.

The conditions causing short-circuit are likely to happen at almost any moment due to accident. They must be removed before the circuit breaker can operate as an effective protection against such dangers.

Direct and Alternating Current Circuit Breakers.—The fact is obvious that a direct current breaks with a much greater arc than an alternating. The presence of inductance in the circuit, however, affects the length of arc to a marked degree. The direct current circuit breaker, therefore, is at a disadvantage up to a certain point, then the high pressure of the alternating current makes the danger of anything but an abrupt and positive break only too apparent. The power factor of an alternating current circuit, is really indicative of the extent to which inductance affects the line. For this reason, circuit breakers must be so designed, that even heavy inductance in the line will not lead to faulty operation on the part of the circuit breaker installed.

Calibration of Circuit Breakers.—One of the most necessary of all tests in the equipment of a station for either central station, street railway or power transmission service, is to be absolutely assured of the reliability of the circuit breaker before it becomes necessary to absolutely depend upon it. This testing of the circuit-breaker, or its calibration, as it is called, is not only done before the instrument is sent out by the manufacturers, but repeated at the station by the superintendent if it is desired to make assurance doubly sure.

Oil Insulation for Protection.—The use of oil as an insulating medium is but one feature of the progress made in the field of protective devices of this character. In oil break circuit-breakers of approved design it is especially desirable to make the break near to the surface of the oil, for the reason that a possibility exists of the oil being defective lower down, in an insulating sense. The break which parts the circuit occurs on special tips, which when injured through repeated use, may be readily replaced.

Poles of the Circuit-Breaker.—Each pole of the circuit-breaker is individually protected, in the high tension alternating current type. Where the amount of power to be controlled is very great each individual break is made to occur in a separate chamber made of concrete, brick or other fireproof insulating and durable material. In cases where oil is used to fill such chambers, it is essential that the height of the oil be visible by means of a small oil gauge situated outside of each. The moving parts of a high tension breaker are rather closely surrounded by a sort of protective hood, which permits the parts to move freely, but reduces the amount of oil to a degree which lessens the danger of an extensive fire yet preserves the insulating value of the equipment.

Use of Indicators in Automatic High Tension Breakers.—The employment of aids, in indicating the condition of the circuit-breaker, if automatic in character, is an invention of great importance. This device is generally mounted on the switchboard where it plays its part in conjunction with a controlling switch in the following manner:

The controlling switch which is of the drum type, has three positions, namely, "Closed," "Off" and "Open," but it will remain of itself in only the "Off" position and the "Open" position. In other words, if it is thrown to the "Open" position it will remain at that position when the hand is removed, but if it is thrown to the "Closed" position, the switch will return of itself to the "Off" position as soon as the handle is free.

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In this position it connects the control circuit so that, if the oil switch opens through the action of any of the automatic devices, a lamp will be lighted on the operating stand to attract the operator's attention. If the oil switch is opened by the operator by throwing the controlling switch to "Open" the lamp does not light.

The Tell-Tale Indicator.—The mechanism of the electro-mechanical tell-tale indicator consists of an electro magnet which attracts a pivoted armature through an angle of about 90 degrees. Attached to the armature is a disk with a pointer which indicates to the eye the open position or closed position of the oil switch. The tendency in high-tension equipments, to supply protective devices as far as possible to the helpers or attendants, is such that no station of any pretensions is other than supplied with means of avoiding any danger to the man in charge.

The idea of placing an indicating device in such a position that the condition of the circuit-breaker is shown, is doubly efficient, not only because of its protectiveness, but through the readiness with which a glance is sufficient to show the presence of trouble, when directed at the switchboard. In this respect it has been found advisable to use disconnecting switches by means of which the circuit-breakers are entirely cut out from service when undergoing inspection.

Circuit-Breakers for 60,000 Volts.—The details entering into the construction of a special type of circuit-breaker may be briefly outlined as follows: They are so constructed that each single pole is individually operative and controlled by levers and toggles to produce a double break. The conductors enter this circuit-breaker armored with the heaviest insulation and enclosed and protected by porcelain bushings beneath the oil surface.

The central operating magnet, by whose action the levers are made to move, is generally mounted in a position where it can be readily examined. Its movable core is the operating principle of the circuit-breaker. By its means, contact is made and broken between the parts of the circuit. These parts are also immersed in oil, and act in such a manner that the tell-tale apparatus is set into operation by the fact of the circuit being open or closed.

The principles observed throughout in the construction are as follows:

1.—Simplicity in construction and therefore positive operation.

2.—Absolute insulation by means of oil and porcelain.

3.—Parts protected from handling.

4.—An automatic recording device to show "Open" or "Closed."

5.—A disconnecting switch to cut circuit-breaker out.

6.—Gaps made in circuit sufficient to cause break.

Separating Contacts.—The idea of separating one set of contacts from another is made necessary by the risk of having them in close juxtaposition, Arcing is impossible under the circumstances, particularly if insulation of the form of alberene stone is employed, as is the case in one type of high-tension circuit-breaker. The oil receiver in a device of this description is made of metal, generally copper, set into concrete. The bottom is lined with wood, and the entire inner surface with alberene stone as a further protection. Wherever a barrier is necessary between contacts, this stone is empioyed as stated. The rating of high-tension circuit-breakers of this type are as follows:

45,000 volts and currents up to 300 amperes.

60,000 volts and currents up to 200 amperes.

Auxiliary Line and Reverse Current Circuit-Breakers.—In very large power installations quite a different phase of the problem is presented in connection with circuit-breakers. To begin with, the principle involved is that of a large power transmitting plant sending energy over a line which is likely to break down due to certain impending or actually occurring disturbances. The discontinuance of service in a line of direct public utility is a calamity best avoided by the installation of auxiliary lines. At Buffalo a reverse current breaker has been installed in order to obviate this very possibility with Niagara power. The principle of its operation is as follows: When the main line breaks down due to a short circuit at two points which directs the current back to its source, the circuit-breaker will naturally open if it is at all effective in this respect. The opening of the circuit-breaker is the danger which the line runs of discontinued service. Therefore, if the current, which is now returning through the short-circuit back to its source, is made to operate the circuit-breaker, by being led back to it through the auxiliary line in the reverse direction, and it then opens, the service will be re-established and continued as before.

The advantage of such a system is found, not only in its operation in this sense, but also with respect to the auxiliary line now doing service. That is to say, just as much protection to the system is necessary with the second system of conductors as the first in conjunction with the circuit breaker. It may be stated in connection with this subject that

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the fundamental principle on which a circuit-breaker works is excess of current and not the direction it takes. Therefore a circuit-breaker, which operates by means of a reverse current, is one which must comply with all the requirements of the first, though the electro-magnetic arrangement is designed to fulfil more than ordinary functions. A circuit-breaker sensitive to current in both directions and automatic in both cases is a valuable addition to large plants in any instance.

The Time of Action in Circuit-Breakers.—The necessity for considering the time of action of a circuit-breaker is apparent in many instances. Some forms of service are peculiarly susceptible to sudden rushes of current. This is particularly so in the case of alternating current plants. In such an instance as this, the heavy rushes of current in the line are caused by the setting into operation of induction motors or large synchronous machines used as motors The same principle applies to trolley service, in which case heavy rushes of current take place due to the various difficulties arising in this form of service.

The time principle necessarily involved in circuit-breakers is made use of in a manner which may be stated as follows:

1. The apparatus nearest to the trouble is protected with circuit-breakers having a certain time element of operation.

2. The apparatus nearest to the power house, possessing its individual time element in the circuit-breakers installed still, does not force the station circuit-breakers to operate immediately. The plan in timing the circuit-breakers is, therefore, of a nature that may be described as relative. An illustration will serve to make this point clear:

(a) Circuit-breaker near trouble operates in 1 second.

(b) Circuit-breaker farther away operates in 3 seconds.

(c) Circuit-breaker still farther away operates in 5 seconds.

(d) Main circuit-breaker operates in 7 seconds.

This plan of timing the circuit-breakers gives the line a chance to clear up before the time elapses required for the operation of the main circuit-breaker at the power house or center of current transmission or distribution.

Something of the same idea is involved in the fusing of circuits, the point being that the smaller fuses go before the bigger ones, thus helping to continue service till the last moment.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability for Death or Injury from Electric Current, Continued—Duty and Liability to the General Public—Wires in Highways, Continued

In the preceding article we discussed the question as to whether or not one was guilty of contributory negligence by failing to see and avoid electric light wires. It is now a fair subject of inquiry whether the person having seen the wire and failed to avoid it is guilty of negligence; this again depends upon the propriety of his taking hold of the wire; but first it should be observed that negligence will not be presumed as to him from the fact of the injury by an electric current when his mouth is closed by death and where the electric company maintains an uninsulated wire upon a reel fastened to an electric light pole so close to the ground as to be within easy reach, although in order to sustain the injury which caused his death who must of course touched the wire. Suburban Elec. Light Co. vs. Nugent 58 N. J. Law 658, 34 At. Rep. 1069.

A policeman who in the discharge of his duty undertakes to remove a wire from the street with his mace on a dark rainy night is not guilty of contributory negligence which will prevent his wife recovering for injuries causing his death where

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the wire was a dangerous public nuisance and hung down in the street. Dillon vs. Allegheny Light Co. 179 Pa. St. 482, 36 At. Rep. 164.

The fact that one uses a street in an unusual manner is not positive evidence of contributory negligence on his part to preclude him from recovering. Thus the fact that one walks across a street diagonally and is struck by a falling pole which would not have struck her had she crossed the street on the crossing does not charge her with contributory negligence nor even tend to establish such negligence when it is not shown that she had the slightest intimation of any danger from using the street in that manner. Denver vs. Serret 88 Fed. Rep. 226, 31 C. C. A. 499.

Thus, where a child passing along the street with his sister saw a wire lying on the sidewalk and thinking it was a switch, picked it up to hit his sister and received an electric shock from it severely injuring him, the company was held liable and it was said that the doctrine presuming negligence from the fact of injury would apply. Norfolk R. & Light Co. vs. Spratley 103 Va. 379, 49 S. E. Rep. 502.

Nor is the driver of a float with a heavy load which exceeds the ordinary height guilty of contributory negligence by sheering to the left side of the street at a crossing in order to avoid a vehicle coming upon an intersecting street, although by reason of such deflection his load comes in contact with a saging electric light wire. Williams vs. Louisiana Elec. Light Co., 43 L. Ann. 295, 8 Southern 938.

In our previous discussions we have considered the law applicable to this field only with reference to adults and have considered the matter of negligence on the part of the company as well as on the part of the subject of the injury with reference to adults only. The law has always made a distinction between adults and children because of the fact that the children are deficient in judgment and are susceptible to different influences.

These rules in turn are subject to modification depending entirely upon the age and capacity of the child from a babe of very tender years to one of more mature years from one of a low degree of intelligence to one superior in these respects.

Therefore, on the part of the defendant the company, it has been made important by the decisions to consider whether the company has been negligent with reference to the propensities of adults and also whether it has been negligent when the natural tendencies of children are involved, for example in a case which was published in THE CENTRAL STATION of May, 1907, Temple vs. McComb City Elec. Light & Power Co. (Miss.), 42 S. O. Rep. 874, it was held that the Electric Light and Power Company was bound to guard against the natural propensities of boys who climb trees with low spreading branches, and, therefore, was liable when a boy who climbed such a tree through which a live wire passed, was injured by touching that wire because, it was not properly insulated. While this is an extreme case, it nevertheless illustrates the limit to which the rule has been carried requiring care to be exercised not to injure children.

Where a boy 14 years of age was killed by taking hold of the wire used in raising and lowering an electric light, when he had no occasion to touch the wire, it was held that his contributory negligence was for the jury and that the company was negligent in so constructing its apparatus that a current could be communicated from the lamp or feed wire to the supporting wire. Lexington R. Co. vs. Fain's Admr. (Ky.) 71 S. W. Rep. 628.

The same was held of a young man not yet of age who took hold of a wire lying in the street, and, after he had been warned to let it alone, threw it over his head in such a manner that it came in contact with a live wire, and the court declared that the question as to whether or not want of care on his part contributed to his injury was a question for the jury to determine. Texarkana Gas, etc., Co. vs. Orr 59 Ark. 215, 27 S. W. 66.

Where a boy of 17 years of age, fully developed, over six feet tall, of studious habits and intelligent, filling a responsible position in a wholesale establishment, finding a storekeeper about to take a wire out of the way with a pair of insulated pliers, as he stated, so that people would not get killed, reaches over the storekeeper's shoulder after he had wound a handkerchief around his hand, there can be no recovery if he is killed because of grasping the wire, since he was so manifestly deficient in care and caution as to have contributed to his own injury. Frauenthal vs. Laclede Gas Light Co. 67 Mo. App. 1.

It is apparent from this case that the boy knew the danger and appreciated the risk he ran as he attempted to insulate himself by wrapping a handkerchief around his hand, the evidence also shows that he was warned by the bystanders and saw that the storekeeper was approaching the wire with insulated pliers. The test in such cases is not infancy but maturity, the question is one of capacity and not non-age, consequently as the evidence clearly indicates that the boy appreciated the danger,

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the question of his age becomes immaterial. These principles are more clearly brought out in Haynes vs. Raleigh Gas Co. 114 N. C. 203, 19 S. E. Rep. 344, 41 Am. St. Rep. 786, 26 L. R. A. 810. In this case the boy killed was about ten years old, very healthy, intelligent, moral, industrious and well educated for his age. On a November morning he assisted his older brother, who was a newspaper carrier, and when returning home about 7 o'clock, took hold of a wire on or near the sidewalk, over which he was passing, and was killed by an electric current. The current came from the feed wire of the street railway company; one of the defendant's poles standing in that street was supported by three guy wires, one attached to a tree on the street on which the pole stood and the other two attached to trees on an intersecting street. One of these crossed the street railway feed wire, while another was hanging to the ground and was the wire which the boy grasped. Upon the question of contributory negligence of the complainant's intestate, the court, after holding that there was no contributory negligence, said: "A child is held to such care and prudence as is usual among children of his age and capacity. The defendant contends that the deceased was ten years of age and a very healthy, intelligent, moral, and industrious boy. Let us assume this to be true. As he returned to his home the morning of his death, passing along the streets of the city, he was trespassing upon no one's property. He was walking where he had a right to walk—not by mere permission or invitation, but because he, as one of the public, had an absolute right so to do. The wire was on the sidewalk. Only one witness saw him when he took hold of it and it threw him in the ditch, and that witness testified that 'he did not have to reach for it; he just reached out his hand and took it; he did not have to stoop.' * * * * We would be very loth to declare an adult guilty of negligence for grasping a wire, such as this one, under circumstances such as the defendant contends surrounded the deceased. We certainly cannot declare that this boy, whose conduct must be regarded with his boyish nature and habits, negligently caused his own death." We believe that enough has been said here without citation of other authorities or further quotation from the cases to establish the soundness of the rules with which the discussion of this subject was begun. The matter of capacity will be considered more at length subsequently when we come to consider injuries to children who are at the time on private property and not upon the public streets.

Liability for Injury by an Electric Current—Foreman—Fellow Servant Doctrine

Plaintiff brought this action to recover damages for injuries received through the negligent closing of an electric switch, whereby a current of electricity was conducted into certain wires upon which plaintiff was working within the line of his duty. The defendant, the Edison Illuminating Company, was constructing and had nearly completed a plant at Delray, in Wayne County. The general manager of the company was Alexander Dow. Immediately under Mr. Dow and having supervision of the operation of the plant at Delray was George W. Cato. Under Mr. Cato was Hiram Ford, who was superintendent of interior construction. Frank Davis, foreman of defendant, and the other electricians and wiremen, worked under the general direction of Mr. Ford. Plaintiff testified: "I was injured there September 26, 1904. I was working at that time under Mr. Davis. His position was foreman of the electricians of the plant which I have been speaking about." At the time of his injury, plaintiff was doing certain work on top of the boilers, putting in conduits, wires, sockets and lamps for lighting above certain boilers in the boiler room, some 21 feet above the floor, for the purpose of lighting the water gauges. On the day before his injury, plaintiff had complained to the foreman that the plant was in a dangerous condition, and, to obviate the danger complained of, a switch box was put in in accordance with plaintiff's instructions. Plaintiff testified: "It was my duty to inspect that box before going to work. I did inspect it. That was in accordance with the rules of electricians. In connection with the inspection I found the box to be perfectly safe. * * * Mr. Davis told me, if I would go up to work there, he would see that that switch box was kept open all the time I was up there. He would see. He would be in a position to do it. I relied upon my inspection first and Mr. Davis' agreement with me, what he said. When I had this conversation with him, he was at the switch box in this plant where it was situated. In the presence of Mr. Davis, for the purpose of making it safe, I threw the switch open. I turned it down. I opened it. I nailed the lid on the box, in that shape (illustrating). My purpose of nailing the lid on the box was so that no person would put their hand in there and throw the lever up. I put a written notice on that box for no person to throw the switch in or some word to that effect. That notice consisted of an official card of the company. That was in the

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line of my duty to do that. * * * He said he would see the switch was kept open every moment I was up there." While working on one of the sockets, "the electricity came on me, and held me there. I could not get off, and it grounded me there. My weight carried me off the floor below. * * * I fell from there to the floor. I account for that—some person threw in the switch. * * * After I fell, I saw Mr. Davis, the foreman, about two or three minutes after. He says, 'I forgot that you were up there.' * * * This man Davis was the foreman of that company. He had charge of all the electricians. It was under him that I was working."

Mr. Davis testified: "I work under the direction of Mr. Ford. His general authority or business was that he superintended the general construction of the work. Mr. Cato was superintendent of all the departments. I do not know who turned that switch." He also testified: "I was watching the general work of the plant, overseeing it, and that was my duty to do that as foreman over those wire workers and electricians and that is what I was doing on that day." After the close of the testimony the court, upon motion of defendant's counsel, directed a verdict for defendant upon the ground that the foreman, Davis, was a fellow-servant of the plaintiff, and the defendant company was not responsible for his negligence, nor bound by his agreement to watch the switch box and see that the switch was not closed.

The Supreme Court says:

"Plaintiff brings the record to this court by writ of error upon various assignments of error, the principal of which, and the only one which we think it necessary to consider, is that the court erred in holding that Davis was a fellow-servant of plaintiff, plaintiff contending that he was a vice principal.

"Upon the foreman's failure to perform his agreement to watch the switch box, and see that it was not interfered with was a failure to discharge a duty which the corporation owed to plaintiff, no negligence was proved on its part. On the contrary, the plaintiff's evidence conclusively demonstrates that, except for the alleged new duty arising from the agreement, the defendant discharged its full duty to the plaintiff. Independent of the agreement, there was certainly no rule of law which made the defendant an insurer of the plaintiff's safety. If the agreement acquired binding force against the defendant, it was not because authority had been impliedly delegated to the foreman to make it in discharge of an absolute duty of the defendant, but because his position as foreman authorized him to bind the defendant to the performance of an absolute duty which theretofore had not existed and which was in derogation of its rules. Whether any officer of a corporation, however high his grade, would be acting within the scope of his authority in making such an agreement for the corporation, it is unnecessary to determine. We are satisfied that the foreman, Davis, possessed no such authority, and that in making the agreement he did not represent the defendant.

The defendant was not liable for the negligence of the foreman, and the court did not err in directing a verdict. Wellihan vs. Wheel Co., 128 Mich. 1, 87 N. W. 75; Mikolojczak vs. No. Amer. Chem. Co. 129 Mich. 80, 88 N. W. 75; Page vs. Battle Creek Pure Food Co., 142 Mich. 17, 105 N. W. 72; Guest vs. Edison Illuminating Co. (Mich.), 114 N. W. Rep. 226.

The 1908 Convention of the National Electric Light Association

After considering several invitations from other cities, and having given careful consideration to the information and suggestions sent in regarding those other places, it has been decided to hold the next convention of this Association at Chicago, Ill., May 19, 20, 21 and 22. The headquarters will be at the Auditorium Hotels, where ample facilities for receptions, meetings and exhibition purposes, together with accommodations for a large number of delegates, all practically under one roof, are available. There are, of course, many other hotels in the immediate vicinity, which can accommodate all the others who attend. The exhibition space will adjoin the Convention Hall, similar to the arrangement at the New Willard Hotel in Washington, during the 1907 convention, and a separate room will be provided for parallel sessions. The executive committee of the Association met on February 20, at the office of the Association in New York, where arrangements for the coming convention were made, and full details of same will be announced in the next issue of THE CENTRAL STATION. Members of the Association having subjects of general interest which they desire to present at the coming convention in the form of papers, should communicate promptly with the secretary, and all manuscript for accepted papers may be delivered any time prior to April 1. The address of the National Electric Light Association is 29 West 39th street, New York City.

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Direct or Indirect Lighting

So great a variety of conditions prevail in what is called commercial lighting, that it is difficult to point to any specific instance of lighting that is not, in part, indirect. The point at issue arising in the case of lighting in general, and yet requiring a distinction between that which is termed direct and indirect, is not whether each is distinctly efficacious, but which is the best. Direct lighting, so called, is merely an instance of where the light developed by a center of illumination radiates upon surfaces near enough to indicate a comparatively bright illumintion. Indirect lighting, as the term implies, is really a case of where the center of illumination throws its light upon a surface very near to it, from which the light is cast down or thrown up, as the case may be.

Many of the halls of office buildings in New York City represent excellent examples of indirect lighting, and the soft, effulgent effect thus produced is not readily forgotten by those who have not been able to grow accustomed to a glaring light. On the other hand, direct illumination is the thing most to be expected, and indicates an effort to place light where it is supposed to belong. The question at issue, therefore, is a secondary one, derived, as it were, from a consideration of what is called direct and indirect lighting. Where should light be placed so that its use develops a form of illumination not only agreeable, physically and æsthetically, but really economical in the accepted sense of the word? It may thus be seen from only a casual survey of the situation that the problem of lighting is one which is dependent upon several factor which must be considered, and which partake of a physical and psychological nature.

The contrast between glaring light and soft light is one about which little need be said, for the primal reason at least, that the least initiated in the science of lighting would readily perserve the difference. But the cases presenting themsedves, where the necessity for direct and indirect lighting arises, makes it necessary for some classification to be made of such instances. It is believed by the great majority that a large loft, workshop, public hall or theater can only be lighted effectively by the production of a great deal of light, and relatively the use of considerable energy. It is acknowledged that the lighting of lofts and factories does call for a sufficient amount of light to serve the purpose of the establishment. But even in this case, differences arise, due to the fact that the loft may be well lighted by a few enclosed arcs in one instance, where such lighting would be considered ineffective, where colors required matching, or goods called for a careful examination.

In a sense, the lighting of nature is both direct and indirect. The sun shining down upon that portion of the earth thus illuminated, affects the vapor mass and bed of air surrounding the earth before the earth beneath is lit. In other words, the media, more or less refractive, through which sunlight passes, tones and softens the brilliant glare that would otherwise ensue. A vast amount of light is thus absorbed, and only a percentage of that produced reaches us on the streets, or in our homes. The light, therefore, which enters through the window in many cases, where the sun is shining on the

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other side of the building, is a natural example of indirect lighting. It is evident, therefore, that as such, it will be generally admitted it cannot be excelled, and in consequence, would act as a strong hint in favor of the answer to be expected.

Where light need not fall directly upon an article for the purpose of close examination referred to, it seems as though a system of indirect lighting would be extremely satisfactory. The tendency which has grown for many centuries, due, no doubt, to the crude inventions in vogue, has been to use one or more brilliant centers of light for purposes of illumination. But since the torch and the candle and the oil lamp have, in a sense, become obsolete, and made way for the incandescent lamp, the arc lamp and tubes of light, opportunities have increased for the production of an illumination which does not impair the eye, combat the æsthetic taste, or lose in efficiency and value. It is not unlikely that a canvass of the situation would lead to the conclusion that indirect lighting is the lighting to attempt, if the possibilities afford the hope that it may be done. On the other hand, the means of avoiding a direct glare are found in the use of various globes and shades by which the eye can be protected. There is no reason why the factory should not be as well equipped in this respect as the residence, for in both cases human eyesight is likely to be impaired, and the efficiency of the lighting system questioned, unless rational precautions are taken in connection with a rational system of illumination.

Efficiency, Life and Cost of Lamps

This trial of propositions is generally associated with the invention and manufacture of incandescent lamps. Recently, since a new interest has been awakened in the lamp industry by a series of improvements which approach the final goal, certain questions have been revived, and discussed. The now historic carbon filament lamp may be considered the cornerstone from which other anticipated possibilities await crystallization. The efficiency of a lamp, like that of any machine utilizing mechanical, electrical or other energy, represents the ratio between the power impressed and the effect obtained. The life, as is well known, is entirely a question of that number of hours during which average service is obtainable. The cost, however, is one which bears a direct relationship to the other two elements considered, and whether high or low, presents a business question which can be readily answered.

Of late, lamps of new filaments have appeared, such as Tungsten and Tantalum, and it can be readily realized that the principles which govern the introduction and use of a lamp are as true in the case of these as with that of the well-known carbon type. The aim and desire of inventors and manufacturers is to build a durable lamp, simple in construction, moderately low in cost, but exceedingly efficient in comparison with the carbon filament lamp. The use of new elements has been largely dependent upon the development of the science of chemistry, and for this reason, perhaps, more than any other, if lamp development lagged, the degree to which this took place might now be easily understood. The great cry has been for lamps of higher efficiency. The day is not far off, though it might be, and is claimed by many, that it has arrived, in which the high efficiency lamp will be entirely in vogue, as was expected by the prophets of the nineteenth century. A lamp of high efficiency is a cover for many sins in the opinion of the expert, largely due to the belief that with this as a starting point, life and cost would ultimately be controlled satisfactorily. The fact that the wattage per candle-power has perceptibly dropped, is not only an evidence of the quality of the lamp now manufactured, but also proof of the excellent regulation prevailing in central stations to which such lamps are connected. One of the features, therefore, intimately associated with the reduction in power per candle of light, is the improvement in service in central stations, arising from the better understanding and control of the situation presented by them.

By far the best time for a type of lamp to manifest its appearance is when the source of power has become so well controlled that questions on this score are simply nil. Some years ago, when the carbon filament was considered a risk when rated at 2½ watts per candle-power, the risk implied was due entirely to the problem involved in regulation of central stations. The times have changed; development in both lamps and stations has become pronounced, and difficulties have been swept aside one after the other. The lamp of to-day, in efficiency, life and cost, far surpasses that of a decade or even five years ago, and there is every probability that the next five years will witness a marvelous change in incandescent lamps, not only as regards the trial of qualifications so far expressed, but in all likelihood, with regard to their structure as well. It must not be believed that present forms were

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not changed, as well as present estimates of success. It is only natural to suppose that they will, and we can depend upon human ingenuity, with its never-failing instinct to develop a remarkable lamp, as far as efficiency is concerned, and equally wonderful in length of life and limited cost.

Averaging the Load

Difficulties manifest themselves in station practice in the way of load variations that express wide differences. The method employed to average up the load, is largely a matter of experience or anticipation. After a station has been operating a certain period of time, the load variations are very well known, and the maxima and minima established. Before a station is built, however, the project must be considered carefully, in order that some practical conclusion can be drawn regarding the average load. The purchase of machinery, the estimate of capacity of generators, the expectations of increased custom and the provision for short but heavy calls for power enter into this consideration.

Averaging the load after the station has been in operation a certain period of time, enables the superintendent to obtain data relative to the percentage of the full load, that may be noted at different hours of the day. For instance, the full load during the late afternoon in winter may be 120 per cent., falling away in about 2 or 3 hours to 100 and then 60 per cent., but rising in value sharply to either 100 or more per cent. when social activities begin and theaters and public halls as well as home are well illuminated. The first outlay for a plant is proportional to the average load or by averaging the load, the first outlay for a plant may be known.

One of the most uncertain elements in all estimates is the rate of growth of business. Also one of the admitted reasons why station service may temporarily become deranged, is because the activity of agents canvassing for business, and their success, is not always paralleled by sufficient development in the station. The point, therefore, of the greatest interest to superintendents, is that of not waiting until the acual load is on the station, but averaging up the load in advance from the signed contracts for current. In other words, station service, need not be exposed to unexpected fluctuations in the way of demand for current. Preparation for even the heaviest load is not in the least a difficult matter if taken in time.

The other question involved in the averaging up of the load is whether the demand for current may not be divided up into two or three classes. One demand may come in the morning and then that class of customers be off the list for the balance of the day. The second demand in the afternoon; the third at night. Each of these demands may not fall far short of the total capacity of the station. Together they would swamp it. But coming at different intervals, a station is able to far exceed its capacity, if the averaging of the load makes this possible and yet never be, in a practical sense, overloaded.

Investments in Plants

Each year means additions to the sum total invested in electric light plants in the United States. Each year also means a change, not only in the lamp or lamps employed to give light, but in the care, means, and therefore the design, of the central stations undergoing construction or development. In consequence of this, it is not difficult to conclude that a complete, by which is meant, a fully equipped station, costs increasingly more each year.

On account of this, a strict proportion cannot be well established between the cost of a plant of a certain number of lights, say ten years ago, and the cost of an equal sized plant to-day. For this reason, investments in stations, may represent a greater sum than might be expected from the capacity of the plants concerned. This fact would be still further demonstrated by the greater cost of labor, particularly of the skilled type, and the increased cost of finished products of the mechanical and electrical type.

In addition, it might be said, that municipal restrictions play a great part due to enforced methods of installation. Also the fire insurance companies make their demands, to reduce, as far as possible, the risks otherwise considered imminent. Increased expense is thus accounted for on other grounds than labor, though the respective values of each of these increments of additional cost, represent per cents which are of the greatest interest respectively.

The sum total expended per annum is, therefore, no gauge of the absolute development in central station practice. The greater proportion may be, but then only in a general way. It is not the bulk of money spent, but that percentage of the

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bulk which represents actual improvements of established value, which really counts along developmental lines. Therefore, the so-called investments in plants possess a peculiar interest to the expert and superintendent, as well as the statistician, because they may herald decided advances in central station equipments, as well as in the total lighting done per annum.

MONTHLY REVIEW OF THE TECHNICAL PRESS

The Development and Present Position of Gas and Electricity for Lighting

By Sydney F. Walker.

The keen struggle that is taking place at the present time between gas and electricity for the custom of users of light, recalls the struggle which was also in progress in 1882, when the first Electrical Exhibition was held. At that time there was a very strong feeling indeed against gas, and very strong hopes on the part of the general public that electricity was going to be the light of the immediate future, and that it was going to be very cheap.

Gas had held the field for a number of years previously, and though the electric light had been known and in use to a limited extent for at least thirty years, practically nothing had been done with it until the years immediately preceding the Exhibition. Numerous inventors had been working at the problem of the division of the electric light, and so strong were the hopes in connection with it, that when Mr. Edison cabled over from New York, a year or two before the Exhibition, that he had solved the problem, gas shares declined some thirty points in value.

At the time of the Exhibition the incandescent lamp had only recently been put upon the market. Mr. (now Sir) Joseph Swan in this country; Mr. Edison in America; Mr. (now Sir) Hiram Maxim, Mr. Lane Fox, and others had been working at the problem, and there were at least four incandescent lamps upon the market, the inventions of those four gentlemen. At the present time the carbon filament lamp which holds the field is made by a process which is practically a modification of that adopted by Mr. Swan at an early date. The Brush arc lighting system had been brought over to this country just previously, and had taught British electrical engineers one method of dividing the electric light. In those days, those of us who were engaged in the struggle could see the numerous faults of the Brush system; but looking back now, we can see what an enormous advance Mr. Brush made by the bold design which he worked out. The date of the actual first advance of electric light would properly be the Paris Exhibition of 1878, when the Jablochoff candle was shown illuminating the Avenue de l'Opera.

But it was the advent of the Brush system in this country which gave the first important impetus to street lighting by arcs. English electrical engineers had been working around the problem of producing a steady arc, but they had found themselves obliged usually to employ one, and sometimes two machines for each arc. Mr. Brush produced forty lamps from each machine, and though the lamps flickered a good deal, they were steadier than the lamps furnished by one or two machines. Mr. Brockie was in

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the field with his early commutating arc lamp immediately afterwards, and his lamp solved the problem of the lighting of open spaces, such as railway sidings, iron works, and colilery yards, and so on, practically as well as the Brush lamp. The present writer fitted up two collieries in the Rhondda Valley, in the year 1881, with Brockie commutating arc lamps. But the wink produced by the feed of the Brockie lamp was too irritating for indoor work. The Brush arc lamp, a number of other arc lamps that were on the market at the time, and all the incandescent lamps that were on the market, were exhibited in large quantities at the Crystal Palace Exhibition of 1882, and the public were asked to subscribe for the purpose of laying down electricity generating stations for supplying towns using some of the lamps exhibited.

The public subscribed some twelve millions sterling, but the lighting of towns by electric light, as we know it now, did not come to pass for a number of years afterwards. Enormous sums were paid for the right to use certain systems in certain districts, and very large sums passed into the hands of company promoters. Companies were established in nearly every district, to exploit different systems, but all have gone the way of all flesh many years ago, and the whole of the lamps that were exhibited at that time, and that were on the market, have long since ceased to exist. Gas was supposed then to be about to receive its death blow, and there were many amusing references to the subject. *The City Press* had a colored cartoon, labeled "The Gas Director's Dream," in which a gas director is supposed to be haunted by the faces of the men who were leading the attack on the side of electricity.

But gas was by no means in a dying condition, and did not receive anything approaching a death blow. Careful observers noted a few years after, even when electricity had overcome some of the difficulties it met with, and was making great headway, that the consumption of gas also was steadily increasing. In fact, it may be said that, from the time of the Electrical Exhibition in 1882, gas has steadily progressed, both in quality and in the quantity consumed. Gas engineers had previously had the easy time which comes from the absence of competition. Parliament had provided that gas companies should not pay more than 10 per cent. without giving a proportional reduction in the price of gas to its consumers. It was much easier to keep the price of gas up, and to pay dividends at the 10 per cent. with which every one was satisfied, and to spend any money that might be over in building handsome offices, and so on, than to bother with improvements.

From the time, however, of the really active competition of electricity, gas engineers put their shoulders to the wheel, and have been steadily improving their product ever since. In 1882 the price of gas was very high. Five shillings a thousand cubic feet was a very common figure, and six shillings, and seven and sixpence were to be found in small towns. The quality of the gas also was very bad. It burned with a smoky, yellow flame, and numerous gas engineers were at work trying to whiten it.

Further, though it had been known since the discovery of the late Sir William Perkin in 1856, that the impurities of gas contained valuable products, very few gas engineers had made much use of them. After the competition of electricity set in, they turned their attention to that, and though the profits supposed to be available from by-products were not always realized, the gas was more thoroughly cleaned, and gas engineers were able to provide a better article, and to steadily reduce the price.

The competition of electric light, as explained above, increased the consumption of gas. One tradesman perhaps lighted the front of his shop with arc lights, and his neighbor endeavored to produce an equally brilliant illumination by means of gas, and the gas company reaped more from the neighbor than they lost from the man who adopted electricity. With the advent of the Welsbach mantle in 1893, the tradesman who employed gas was able to make quite as brilliant a display with gas as his neighbor could with electricity, and at much less cost.

The Welsbach mantle only became practical in 1893, and at the third time of trial. In 1886, and again a few years later, it was introduced to the public with the usual flourish of trumpets, and was supposed to have given the gas companies the weapon they were wanting to enable them to compete with electricity, but in both cases it disappeared shortly after from the market. In 1893 it became a practical success, and gas has not looked back since.

The mantle became successful just in the nick of time. At the moment electricity was going ahead by leaps and bounds. Nearly every town was laying down an electric lighting plant, and there was great enthusiasm for the electric light, while the difficulties in the way of economical production and of distribution had not been thoroughly realized. It may be mentioned incidentally that the Electric Lighting Act of 1882 is blamed for the want of

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progress between that year and 1888. The real reason was, the problems involved in economical distribution, and even the problem of the dynamo itself, had not been worked out. It was not until 1884, when the late Dr. Hopkinson and Mr. (now Prof.) Kapp worked out the law of the dynamo, that electrical engineers were able to design dynamos with any certainty that they would accomplish what their designers intended them to. From 1884 the progress of electricity has been continuous. There were also difficulties in connection with electrical distribution, that hardly have a place in this article, but which retarded the progress of electric lighting.

Further, when electricity generating stations were more or less in full swing, it was found that they were very seriously handicapped in competition with gas by the fact that light was only required for a very short portion of the twenty-four hours, by the bulk of those who were disposed to use electricity, even in the winter months, and hardly at all during the summer months. A number of the towns also had handicapped themselves by the adoption of the alternating current, which cut them out of the motor load and prevented the use of storage batteries.

Meanwhile gas was not idle. What is known as high pressure gas was introduced in about 1898 or 1899, the development of the gas mantle enabling this to be done. The principle of high pressure gas may be taken approximately to be the same as that of forced draught. A more perfect combustion is obtained, with an economy in gas and better light. At the Glasgow Exhibition in 1901, portions of the grounds were illuminated by different forms of high pressure gas, and other portions by different forms of arc lamps, and though the arc lamps gave more light individually, when measured photometrically, than the high pressure gas, for practical purposes the grounds illuminated by gas were just as well lighted as those illuminated by the arc light. Since then high pressure gas has steadily advanced, and is in use in a great many towns of the United Kingdom, its use enabling street lighting to be carried out quite as efficiently as by arc lighting, and at a lower cost.

The improvement of the gas mantle also has enabled the gas companies to practically secure the lighting of the side streets, suburban roads, etc., with gas mantles under ordinary pressure. The gas mantle itself has been enormously improved, and the using public have learned to know how to get the best results from it. Later forms are made very much stronger than those of a few years back, so that they can be handled with impunity, and the fittings can be taken down, the dust cleared away from them, and the mantle when relighted is nearly as good as when new.

Against all this, electricity has produced the flame arc lamp, the mercury vapor lamp, the Nernst lamp, the metallized carbon filament lamps, and the metallic filament lamps, and the real struggle is now to commence.

The flame arc lamp gives a very much larger amount of light for the same expenditure of electricity than the ordinary arc, but it is difficult, under a large number of the conditions ruling, to make effective use of the increase.

The mercury vapor lamp has not "caught on" yet to any great extent, on account of its weird color, though its efficiency is high, and it appears to be of use for a good many purposes, such as the lighting of offices, printing works, etc. Probably the prejudice against it will be overcome in time, and the public will get used to it, just as they have done to the arc lamp.

The real struggle is between the Nernst lamp, the later forms of carbon filament lamp, the metallic filament lamps, and the later forms of Welsbach mantle. At the present time, in the writer's view, gas is winning, and still holds winning cards. The great advantage possessed by electricity in the matter of convenience is still a very strong card, but gas engineers have learned to copy electricity in a great many respects, and have succeeded in arranging their lights, in many cases, quite as conveniently as electric lights, the pilot light of the gas mantle providing a means of turning lights in and out at a distance. The very high efficiency of the metallic and later forms of carbon incandescent electric lamps give electricity a very strong card, which, if the corporations use it wisely, will enable them to make a good fight with the gas companies.

In the writer's view, there is no question of either light extinguishing the other. Both will go on side by side, the healthy competition between the two leading to continual improvement and continual lessening of cost.

The great danger is the possibility that both may be extinguished by the discovery by some savant of the secret of the light emitted by the firefly. This may seem far-fetched, yet when we remember the enormous number constantly asking nature to surrender her secrets, we should hardly be surprised if the secret mentioned should be discovered at any moment.—*London Illuminating Engineer.*

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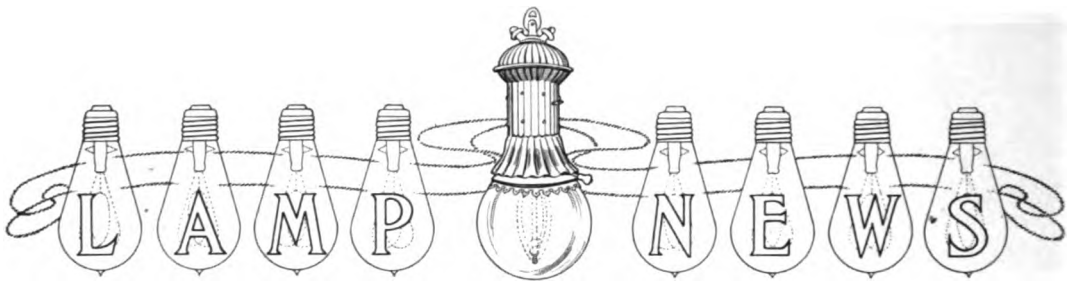

The Westinghouse Lamp Company announces that the New Jersey and New York Circuit Courts have ordered the discharge of the company's receivers, and the return of the property to the stockholders. These orders become effective March 1, 1908, and after that date the management of the company will be conducted by the executive officers as prior to the receivership.

The business of the company has been carried on at a considerable profit during the receivership, and there has been no cessation in the development and factory operations.

The new factory of the company at Bloomfield is now in operation, and arrangements are being made to concentrate all of the manufacturing at that plant. The output of this admirably adapted plant will be about 15,000,000 lamps annually.

In order to provide for the very heavy demand for Edison lamps, and to take care of the new developments in Gem, Tantalum and Tungsten lamps, the General Electric Company have in the past year built four new factories at East Boston, Toledo, O., Fort Wayne, Ind. and Newark, N. J.

The factory at Toledo is confined to the production of Gem filament lamps only. That of the Newark factory to Tungsten lamps only, and the factories at East Boston and Fort Wayne to the regular carbon filament lamps. In addition the General Electric Company has erected a new factory building at Harrison, N. J., adjoining the present lamp factory, which is devoted to the production of Tungsten lamps.

In addition to these new factories the main factory at Harrison, N. J., continues its large output of carbon and Gem filament lamps. The total productive facilities of the General Electric Company now aggregate sixty million lamps per year, so that they are in excellent position to supply all demands from customers.

The Hotel Jefferson, one of the finest and best appointed hotels in the West, located at St. Louis, recently installed 8,200 Bryan Marsh Tantalum lamps. The hotel management is delighted with the increased illumination which they secure at a great reduction in total cost of current.

The only trouble at this writing is that the guests take so kindly to the Tantalum lamps that they are putting them in their baggage when they leave the hotel. This is a great compliment to the lamp, but rather hard on the fellow who has to pay for it.

The Sunbeam Incandescent Lamp Co., of New York and Chicago, reports a splendid business with its new Sunbeam Tungsten lamps. The fact that their customers are pleased with these lamps is proved by the constantly increasing repeat orders which are pouring in daily, both to the New York and the Chicago office.

Mr. Geo. A. Hayes has resigned his position as manager of the Nernst Lamp Co., at Omaha, Neb., and will report this month to join the sales force of the Buckeye Electric Co., of Cleveland.

Mr. L. A. Brown, formerly of the Cleveland office of the Nernst Lamp Co., has recently joined the force of the Buckeye Electric Co., of Cleveland.

The General Electric Company, Schenectady, N. Y., reports largely increased sales of Tantalum lamps, which is especially noticeable for those of 40-watt capacity. The lamps are giving most excellent service, and are thoroughly satisfactory and successful. From present indications the Tantalum lamp, particularly the 40-watt size, will prove a good supplement to the Tungsten, as it is a hardier and less expensive lamp, is of smaller size and more

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adapted to general conditions. The Pennsylvania Railroad terminals at Philadelphia and Jersey City are lighted with Tanutalum lamps, and the General Electric Company also has the following large installations of them in the Metropolitan district: Metropolitan Life Insurance Building, 9,000; Broadway and Maiden Lane Building, 6,000; St. Dennis and Martinique Hotels, 5,000; Blair & Co.'s Building, 2,000; Hahne & Company, Newark, N. J., 1,000.

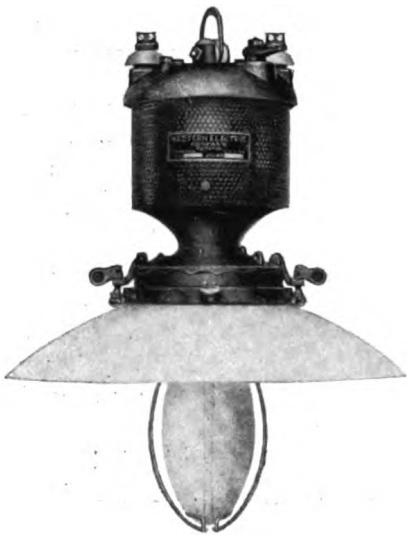
Mr. James C. Wormley, president of the Downward Light Electric Co., of New York City, manufacturers of the Downward Light incandescent lamp, has met with marked success with this style of lamp, and by the introduction of new and special machinery in the new factory, is now able to turn out a most perfect lamp of the tipless variety. By the peculiar formation of the filament of the Downward Light lamp, Mr. Wormley claims that it gives seventy per cent. more light in a downward direction than the ordinary sixteen candle-power lamp consuming from fifty-one to fifty-six watts. The Downward Light lamp, it is claimed, consumes but forty watts.

The above company states that it is now prepared to fill orders promptly, and guarantees its shipments as to life, accuracy and uniformity of assortment.

Western Electric Co., of Chicago and New York, has developed a new special type of short arc lamp, which is known as the "Hawthorne," for indoor service. The lamp, as shown in the cut, is but twenty inches long over all, and permits an even distribution of light with very low ceilings. The enclosed globe is of the same standard size as is used in the long lamps, permitting the use of both long and short lamps in installations without the necessity of carrying two lines of glassware. This lamp burns one hundred hours with one trimming, and the efficiency and utility have not been sacrificed in any way by the reduction of the length of the lamp.

Various demonstrations have been made, comparing the illuminating effects of incandescent lamps, both of the carbon filament and metal filament types, and while the latter types have given most excellent results, in many cases the light from the enclosed arc lamp has proved itself superior to all others in the matching of colors of materials, the results obtained by the use of the enclosed arc lamp being more nearly daylight than the light given from any other practical illuminant.

Another type of arc lamp now being placed upon the market by the Western Electric Company is



"HAWTHORNE" SHORT ARC LAMP.

equipped with what they call an indicator drop. This feature consists of an indicator which is ordinarily concealed within the case of an arc lamp, but drops through a slit in the lower part of the case when the lamp requires trimming. This indicator is especially valuable where lamps are burned intermittently, or for various lengths of time and which are not trimmed regularly, as is the case

ARC LAMP WITH INDICATOR DROP.

with arc lamps burning steadily. Without such an indicator, it becomes necessary to inspect arc lamps at frequent intervals, in order to insure againt failure due to the carbons being consumed, and the con-

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sequent burning and destroying of the carbon holders in the lamps. By the use of this new type of lamp, warning is given before the carbon is totally consumed, which, of course, means the most economical use of carbons.

Multiple Luminous Arc Lamp

The luminous metallic arc is now recognized as the most efficient and best all-around street illumination in commercial use. This system of street lighting having passed the experimental stage, is now in quite general use. For low voltage, direct current multiple circuits, however, there has been but little use made of the luminous arc lamp.

The General Electric Company has now on the market a luminous arc lamp for operation in multiple on direct current circuits of from 100 to 125 volts. The general form of this lamp can be seen by referring to Figure 1. The casing is of solid

FIG. 1.

copper with a black oxidized finish and of sufficient thickness to form a durable housing for the lamp mechanism, as well as a substantial support for the outer globe and its supporting ring.

Figure 2 is an interior view, showing the mechanical construction of the lamp. The main frame consists of a 1½" iron pipe connecting the top and bottom castings. This method gives a rigid construction and at the same time provides a suitable center draft or chimney for disposal of the arc fumes. At the top this chimney is protected from rain and snow in such a manner as not to interfere in any way with the natural and uniform draught required for the proper action of the arc.

The upper or positive electrode consists of a drop forging of copper. With a large volume of copper and a large radiating surface, it is possible to keep this electrode at a low temperature. This condition

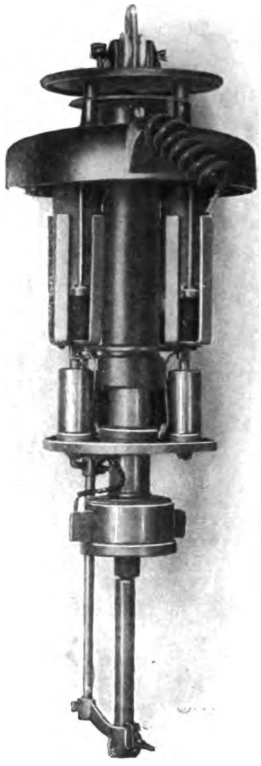

FIG. 2.

together with the peculiar characteristics of the luminous arc, results in a slow wearing away of the copper. The copper electrode in a 4-ampere lamp will require renewal after about 1,800 hours opera-

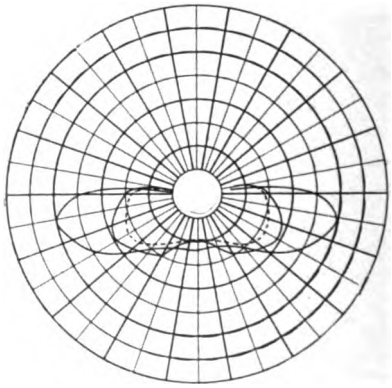

FIG. 3.

tion; or with an average burning of 5 hours per day will last about one year.

The lower electrode which is responsible for the flaming characteristic of this lamp is an iron tube

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about ¾" in diameter filled with a prepared composition. One electrode only is used at each trimming, with a life of about 150 hours.

There are two single magnets, with two armatures mechanically connected. The action is positive and at the same time remarkably sensitive, responding quickly to any variations of the line or arc, and thus maintaining a close regulation of the current.

dling, cleaning and renewing. The luminous arc lamp is specially recommended for the lighting of foundries, machine shops, train sheds, freight houses, drill halls and riding academies.

The following table shows the total cost of operating various lamps on various costs of power. The combined cost of power and lamp renewals, for a

Table of Combined Cost of Power and Lamp Renewals for 1000 Hours — Cost of Power per Kilowatt Hour	Designation....	1	CARBON				GEM					TANTALUM				TUNGSTEN	
												Direct Current		60 ~ Alternating			
	C. P.	2	16	16	32	32	20	40	50	75	100	20	40	20	40	32	48
	Nominal W. P. C.	3	3.1	3.5	3.1	3.5	2.5	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	1.25	1.25
	Actual W. P. C...	4	3.1	3.5	3.1	3.57	2.5	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	1.25	1.25
	Total Watts.....	5	49.6	56.0	99.2	114.24	50.0	100.0	125.0	187.5	250.	40.	80.	40.	80.	40.	60.
	Hours Total Life.	6	587.5	1162.5	593.75	1200.	560.	575.	560.	560.	560.	1400.	1600.	600.	900.	1000.	1000.
	K. W. H. Consumed during life	7	29.14	65.10	153.4	137.09	28.0	57.5	70.0	105.0	140.0	56.	128.0	24.0	72.0	40.	60.
	Cost of Lamp	8	.16	.16	.24	.24	.20	.28	.36	.52	.64	.48	.68	.48	.68	1.20	1.40
	Cost of Renew'ls per 1000 Hours	9	.272	.138	.404	.200	.357	.487	.643	.929	1.143	.343	.425	.80	.756	1.20	1.40
	.006	10	.570	.474	.999	.885	.657	1.087	1.393	2.054	2.643	.583	.905	1.040	1.236	1.44	1.76
	.008	11	.669	.586	1.198	1.114	.757	1.287	1.643	2.429	3.143	.663	1.065	1.120	1.396	1.52	1.88
	.010	12	.768	.696	1.396	1.342	.857	1.487	1.893	2.804	3.643	.743	1.225	1.200	1.556	1.60	2.00
	.012	13	.867	.810	1.594	1.571	.957	1.687	2.143	3.179	4.143	.823	1.385	1.280	1.716	1.68	2.12
	.014	14	.966	.922	1.793	1.799	1.057	1.887	2.393	3.554	4.643	.903	1.545	1.360	1.876	1.76	2.24
	.016	15	1.066	1.034	1.991	2.028	1.157	2.087	2.643	3.929	5.143	.983	1.705	1.440	2.036	1.84	2.36
	.018	16	1.165	1.146	2.190	2.256	1.257	2.287	2.893	4.304	5.643	1.063	1.865	1.520	2.196	1.92	2.48
	.020	17	1.264	1.258	2.388	2.485	1.357	2.487	3.143	4.679	6.143	1.143	2.025	1.600	2.356	2.00	2.60
	.022	18	1.363	1.370	2.586	2.713	1.457	2.687	3.393	5.054	6.643	1.223	2.185	1.680	2.516	2.08	2.72
	.024	19	1.462	1.482	2.785	2.942	1.557	2.887	3.643	5.429	7.143	1.303	2.345	1.760	2.676	2.16	2.84
	.026	20	1.562	1.594	2.983	3.170	1.657	3.087	3.893	5.804	7.643	1.383	2.505	1.840	2.836	2.24	2.96
	.028	21	1.661	1.706	3.182	3.399	1.757	3.287	4.143	6.179	8.143	1.463	2.665	1.920	2.996	2.32	3.08
	.030	22	1.760	1.818	3.380	3.627	1.857	3.487	4.393	6.554	8.643	1.543	2.825	2.000	3.156	2.40	3.20
	.032	23	1.859	1.930	3.578	3.856	1.957	3.687	4.643	6.929	9.143	1.623	2.985	2.080	3.316	2.48	3.32
	.034	24	1.958	2.042	3.777	4.084	2.057	3.887	4.893	7.304	9.643	1.703	3.145	2.160	3.476	2.56	3.44
	.036	25	2.058	2.154	3.975	4.313	2.157	4.087	5.143	7.679	10.143	1.783	3.305	2.240	3.636	2.64	3.56
	.038	26	2.157	2.266	4.174	4.541	2.257	4.287	5.393	8.054	10.643	1.863	3.465	2.320	3.796	2.72	3.68
	.040	27	2.256	2.378	4.372	4.770	2.357	4.487	5.643	8.429	11.143	1.943	3.625	2.400	3.956	2.80	3.80
	.045	28	2.504	2.658	4.868	5.341	2.607	4.987	6.268	9.366	12.393	2.143	4.025	2.600	4.356	3.00	4.10
	.050	29	2.752	2.938	5.364	5.912	2.857	5.487	6.893	10.304	13.643	2.343	4.425	2.800	4.756	3.20	4.40
	.055	30	3.000	3.218	5.860	6.483	3.107	5.987	7.518	11.242	14.893	2.543	4.825	3.000	5.156	3.40	4.70
	.060	31	3.248	3.498	6.356	7.054	3.357	6.487	8.143	12.179	16.143	2.743	5.225	3.200	5.556	3.60	5.00
	.065	32	3.496	3.778	6.852	7.626	3.607	6.987	8.768	13.117	17.393	2.943	5.625	3.400	5.956	3.80	5.30
	.070	33	3.744	4.058	7.348	8.197	3.857	7.487	9.393	14.054	18.643	3.143	6.025	3.600	6.356	4.00	5.60
	.075	34	3.992	4.338	7.844	8.768	4.107	7.987	10.018	14.992	19.893	3.343	6.425	3.800	6.756	4.20	5.90
	.080	35	4.240	4.618	8.340	9.339	4.357	8.487	10.643	15.929	21.143	3.543	6.825	4.000	7.156	4.40	6.20
	.085	36	4.488	4.898	8.836	9.910	4.607	8.987	11.268	16.867	22.393	3.743	7.225	4.200	7.556	4.60	6.50
	.090	37	4.736	5.178	9.332	10.482	4.857	9.487	11.893	17.804	23.643	3.943	7.625	4.400	7.956	4.80	6.80
	.095	38	4.984	5.458	9.828	11.053	5.107	9.987	12.518	18.742	24.893	4.143	8.025	4.600	8.356	5.00	7.10
	.100	39	5.232	5.738	10.324	11.624	5.357	10.487	13.143	19.679	26.143	4.343	8.425	4.800	8.756	5.20	7.40
	.105	40	5.480	6.018	10.820	12.195	5.607	10.987	13.768	20.617	27.393	4.543	8.825	5.000	9.156	5.40	7.70
	.110	41	5.728	6.298	11.316	12.766	5.857	11.487	14.393	21.554	28.643	4.743	9.225	5.200	9.556	5.60	8.00
	.115	42	5.976	6.578	11.812	13.338	6.107	11.987	15.018	22.492	29.893	4.943	9.625	5.400	9.956	5.80	8.30
	.120	43	6.224	6.858	12.308	13.909	6.357	12.487	15.643	23.429	31.143	5.143	10.025	5.600	10.356	6.00	8.60
	For each one cent difference in cost, add or subtract...	44	.0170	.0086	.0168	.0083	.0179	.0174	.0179	.0179	.0179	.0071	.0062	.0167	.0111	.01	.01
	Cost of Renewals per 1000 K. W. H	45	$5.49	$2.46	$4.50	$1.75	$7.14	$4.87	$5.14	$4.95	$4.57	$8.57	$5.31	$20.00	$9.44	$30.0	$23.33

The list prices and discounts in this table are given solely to assist in calculation. They are correct at this date but are liable to change without notice. Line 8 shows the cost of lamps to consumers using 10,000 lamps per year, and when used in connection with line 44 enables one to calculate what it costs him to light with any cost of lamps and power.

Figure 3 shows a comparison of photometric measurements of a 5 ampere D. C. enclosed arc, a 7.5 ampere A. C. enclosed arc and a 4 ampere magnetite arc. Even with the decreased wattage the increased candle-power, as shown by the outer curve, is noticeable. The characteristic distribution of the luminous arc, with its maximum intensity near the horizontal, is well known. This natural distribution can be changed to meet other street lighting requirements by the use of correctly designed concentric wave reflectors.

In general, the lamp needs little attention; less in fact, than the enclosed lamp, as there are no enclosing globes and gas caps to require careful han-

period of 1,000 hours, shows the saving effected by the use of high efficiency lamps, when the cost of power is high.

At costs of power greater than 2c. per kilowatt hour the Tungsten lamp is the cheapest, considering both the first cost of the lamp and the cost of power, excepting only the higher candle-power Tantalum lamp. The latter is cheaper than the Tungsten at costs of power below 2½c. per kilowatt hour on 60-cycle alternating and 4c. per kilowatt hour on direct current. This warrants us in saying that for all practical purposes the Tungsten lamp may be regarded as the cheapest source of light considering all forms and types of incandescent electric lamps,

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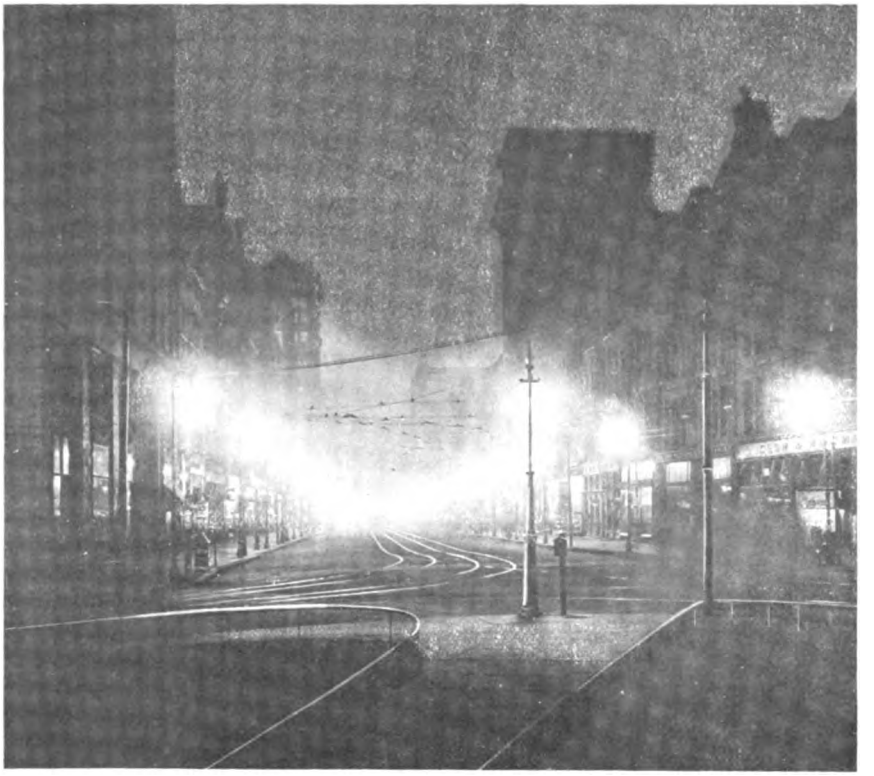
Multiple Arc Lamps as a Means of Lighting Business Sections

The illumination of business sections is a matter in which the enterprising retail merchant is greatly interested. The best lighted streets being the most traversed, added opportunities for business are afforded. This is true in cities both large and small.

The enclosed arc lamp is recognized as the most desirable artificial illuminant, being one which with a minimum amount of energy, produces a strong, well-diffused light, the quality of which is the nearest approach to daylight.



BUSINESS SECTION OF CLEVELAND, O., LIGHTED BY A. B. ARC LAMPS.

The merchants and lighting companies by combining their efforts, have in many cities produced results of which they can justly be proud. The lighting of lower Euclid avenue, lower Prospect avenue, East Ninth street from Prospect avenue to Superior avenue, and Superior avenue from the Public Square to East Ninth street, Cleveland, Ohio, is representative of exceptionally well-lighted business sections.

The "A-B" multiple arc lamp is used for lighting these thoroughfares. It has been adopted as a standard by many lighting companies, and is highly endorsed by merchants everywhere, who have found from experience that it can be depended upon for constant and efficient service. Low cost of maintenance is a feature which has appealed strongly to the lighting interests.

In lighting the sections of Cleveland to which reference has been made, the lamps are suspended from ornamental poles, to which the attractive appearance of the lamp readily lends itself.

By providing suitable lighting for show windows, in connection with street lighting of this nature, the merchant is enabled to display his wares to great advantage. The use of multiple arc lamps for the lighting of business sections is now becoming general in enterprising communities, and is often the logical solution of the lighting problem in small cities.

Government Specifications for Carbon-Filament Electric Lamps

1. SAMPLES.

To show construction, bidders must, if requested, submit two samples of each type of lamp proposed to be furnished. All lamps must conform to the samples submitted, in shape of bulb, mechanical construction, and type of filament, and no departure from the sample lamps will be permitted without the written consent of....

2. COMPARATIVE TESTS.

In determining the award of a contract ....may require bidders to submit for a comparative test 500 lamps. Such test will be conducted with a procedure similar to that outlined in these specifications for inspection and tests of lamps ordered under contract, modified as follows:

(1) Inspection of 50 per cent. of each lot of 500 lamps to discover faults in construction and sorting.

(2) Determination of the uniformity, or non-uniformity, of rating, and the characteristics of the distribution of light of the lamp, including the measurement of about 100 lamps of each lot of 500 to determine the mean horizontal, tip, and mean spherical candle-power, together with the current consumption.

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(3) Determination of mean spherical candle-power performance throughout the useful life of 25 lamps of each lot of 500 submitted, operated at voltages corresponding to an initial specific consumption of 3 watts per mean spherical candle.

3. Standard Incandescent Lamps.

Incandescent lamps to be furnished under this contract shall be new lamps and shall be guaranteed to be in accordance with the following specifications:

4. General Conditions.

The provisions of these specifications shall be binding upon all lamps specifically mentioned herein, or in schedules, by voltage, candle-power, watts per candle, type, and base, and upon no other lamps, except by mutual written agreement.

These specifications shall not apply to any frosted, colored, or other lamps than with the usual clear-glass bulbs, unless otherwise specifically included. Frosted lamps shall be represented in initial tests, inspection, and life tests by bare lamps selected from the lots before frosting.

All tests shall be made in a competent and expert engineering manner at the expense of ..... excepting that when initial inspection and tests are made at the factory the contractor will be required to supply the necessary equipment, assistance, current, and facility for making the tests. The manufacturer, or his agent, shall have the privilege of witnessing and verifying all tests of his lamps made hereunder, and shall also be privileged to obtain copies of the tests of his lamps and have access to the record of such tests at all reasonable times.

With the consent of the contractor, the method of test procedure may be modified in any particular, whenever such change is desirable to secure test results in a more practicable, representative, or accurate manner.

5. Definitions and Standards.

Unit of Candle-power.—The unit of candle-power shall be the candle as determined by the Bureau of Standards at Washington, D. C.

Photometric Measure.—The basis of comparison of all lamps shall be the mean spherical candle-power. The nominal candle-power referred to in these specifications shall be the mean horizontal candle-power of lamps having a mean spherical candle-power value of 82.5 per cent. of the mean horizontal candle-power, which is the standard value for filaments of the oval anchored type.

For lamps having filaments giving a different ratio of mean spherical to mean horizontal candle-power, the horizontal candle-power measurement will be corrected by a reduction factor determined by the Bureau of Standards or other authority mutually agreed upon.

Test Quantity.—The test quantity shall consist of 10 per cent. or more of any lot or package, and in no case shall be less than 10 lamps.

BUSINESS SECTION OF CLEVELAND, O., LIGHTED BY A. B. ARC LAMPS.

6. Method of Test.

From each package there will be selected at random the test quantity for the purpose of determining the mechanical and physical characteristics of the lamps, the individual limits of candle-power and watts, and finally the life and candle-power maintenance. These lamps will be known as the test lamps.

7. Mechanical and Physical Characteristics.

All lamps shall conform to the manufacturer's standard shapes and sizes of bulbs, and to the standard forms of filament, and the standard candle-power and watts ratings.

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8. BULBS.

All bulbs shall be uniform in size and shape, clear, clean, and free from flaws and blemishes.

9. BASES.

All lamps, unless otherwise specified, shall be made with moisture-proof standard Edison screw bases, fitted with glass buttons. The shells of the bases shall be of good quality brass, firmly and accurately fitted to the bulb with moisture-proof cement, and in length to conform to the Electric Code of the National Board of Fire Underwriters.

10. FILAMENTS.

The lamp filament must be symmetrically disposed in the bulb and shall not droop excessively during the life of the lamp, when the lamp is burned on test in one horizontal position at a voltage corresponding to an initial specific consumption of 3.76 watts per mean spherical candle.

All filaments must be uniform and free from imperfections, spots, and discolorations.

11. LEADING-IN WIRES.

Leading-in wires must be fused into the glass with the joints between the copper and platinum wires bedded well within the glass, and must be straight, well separated, and securely soldered to the base and cap, without excess of solder. The threads of the base must be free from solder.

12. VACUUM.

Al lamps must have first-class vacuum, showing the characteristic glow of good vacuum when tested on an induction coil.

13. MARKING.

A printed label, showing manufacturer's name or trade-mark, voltage, and candle-power, must be placed on each lamp near base.

14. IN GENERAL.

The lamps must be well made and free from all defects and imperfections, so as satisfactorily to meet the conditions of the lighting service.

15. REJECTION FOR DEFECTS.

If 10 per cent. of the test quantity of lamps selected from any package shown any physical defects incompatible with good workmanship, good service, or with any clause of these specifications, the entire lot from which these lamps were selected may be rejected without further test when tests are made at the lamp factory. When the tests are made elsewhere, if the first test quantity proves unacceptable, 20 per cent. more lamps will be selected from the package or lot of lamps, and should 10 per cent. of this second lot of sample lamps be found to have any of the physical defects above mentioned, the entire lot from which these samples were selected may be rejected without further test.

16. INITIAL LIMITS.

When tested at rated voltage, the test lamps shall not exceed the limits given in schedule. If 10 per cent. of the test lamps from any package is found to fall beyond the limits stated, when tests are made at the lamp factory, the entire lot from which these lamps were selected may be rejected without further test. When tests are made elsewhere, if the first test quantity proves unacceptable, 20 per cent. more lamps will be selected from the package or lot of lamps, and should 10 per cent. of these additional lamps be found to fall beyond the limits, the entire package may be rejected without further test.

17. LIFE AND CANDLE-POWER MAINTENANCE.

Life tests shall be made as follows: From each accepted package of lamps, two sample lamps shall be selected which approximate most closely to the average of the *test quantity*. One of the two lamps thus selected will be subjected to a life test and designated as the *life-test lamp*, the second or duplicate lamp being reserved to replace this *test lamp* in case of accidental breakage or damage during the life test. The *test lamps* shall be operated for candle-power performance at constant potential, average variations of voltage not to exceed one-fourth of 1 per cent., either side.

The voltage for each lamp shall be that corresponding to an initial specific consumption of 3.76 watts per mean spherical candle, or if tested upon a different basis, the results shall be corrected to a basis of 3.76 watts per mean spherical candle. If desired, the life tests may be made at such other watts per candle as may be mutually agreed upon.

Readings for candle-power and wattage shall be taken during life at the marked voltage of the lamps at approximately fifty hours, and at least every one hundred hours afterwards until the candle-power shall have fallen 20 per cent. below the initial candle-power, or until the lamp breaks, if within that period. The number of hours the lamp burns until the candle-power has decreased to 80 per cent. of its initial value, or until the lamp breaks, if within that period, is known as the usual or effective life.

The average candle-power of lamps during life shall not be less than 91 per cent. of their initial candle-power. In computing the results of test of a lot of lamps the average candle-power during life shall be taken as the arithmetical mean of the values for the individual lamps of the lot tested.

Lamps selected for the life test, which for any

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reason do not start on such test, shall be replaced by others.

Lamps which are accidentally broken but not burned out on test shall not be counted to diminish the average performance.

On all tests for determining average candlepower and life each package which will be affected by the results of test shall have at least one lamp on such test.

Accurate recording voltmeter records will be obtained during the test on lamps to show the average variation on the circuit.

When so tested the average useful life values of the lamps shall be at least as great as those given in the following tables.

*For 100-130 Volt Lamps.**

Rating. Rated candlepower, mean horizontal.	Rating. Initial watts per mean horizontal candle.	Initial Limits. Individual candlepower limits.	Initial Limits. Mean candlepower limits.	Initial Limits. Indivual watts limits.	Initial Limits. Mean watts limits.	Average Performance. Useful or effective life in hours to 20 per cent drop in candlepower at 3.1 watts per candle.
4	4.8	1 c.p. above and 1 c.p. below.	0.6 c.p. above and 0.6 c.p. below	12 per cent. above and 12 per cent. below.	6 per cent. above and 6 per cent. below.	300
5	4.2	....do.....	....do.....	.....do.....	.....do.....	300
6	3.7	....do.....	....do.....	.....do.....	.....do.....	300
8	3.1	....do.....	....do.....	10 per cent. above and 10 per cent. below.	5 per cent. above and 5 per cent. below.	300
	3.6	....do.....	....do.....			330
10	3.1	....do.....	....do.....	.....do.....	.....do.....	330
	3.6	....do.....	....do.....	.....do.....	.....do.....	390
12½	3.1	....do.....	....do.....	.....do.....	.....do.....	390
	3.6	....do.....	....do.....	.....do.....	.....do.....	450
16	3.1	7½ per cent. above and 7½ per cent. below.	2½ per cent. above and 2½ per cent. below.	5.5 per cent. above and 5.5 below.	2½ per cent. above and 2½ below.	420
	3.5					450
20	3.05	....do.....	....do.....	.....do.....	.....do.....	420
	3.5	....do.....	....do.....	.....do.....	.....do.....	350
24	3.1	....do.....	....do.....	.....do.....	.....do.....	350
25	3.6	....do.....	....do.....	.....do.....	.....do.....	430
32	3.1	....do.....	....do.....	.....do.....	.....do.....	430
	3.6	....do.....	....do.....	.....do.....	.....do.....	400
50	3.6	....do.....	....do.....	.....do.....	.....do.....	300
75	3.6	....do.....	....do.....	.....do.....	.....do.....	...
100	3.6	....do.....	....do.....	.....do.....	.....do.....	...

For 200-250 Volt Lamps.

8	4.4	2 c.p. above and 2 c.p. below.	1 c.p. above and 1 c.p. below.	15 per cent above and 15 per cent below.	7½ per cent above and 7½ per cent below.	120
10	4.25	....do.....	....do.....	.....do.....	.....do.....	130
16	3.8	15 per cent. above and 15 per cent below.	7½ per cent. above and 7½ per cent below.	12 per cent above and 12 per cent below.	6 per cent above and 6 per cent below.	
20	3.8	....do.....	....do.....	.....do.....	.....do.....	160
24	3.8	....do.....	....do.....	.....do.....	.....do.....	150
32	3.8	....do.....	....do.....	.....do.....	.....do.....	150
50	3.8	....do.....	....do.....	.....do.....	.....do.....	120

* It is recommended that every effort be made to avoid ordering lamps of actual rated voltages 105 and below, 109, 110, and 111, 120 and above, and from 218 to 222, inclusive.

In case both test and duplicate lamps are broken or damaged before the life test is completed, the average performance of all lamps of the same class previously tested under the same contract shall be assigned to the package represented.

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(*a*) VALUES FOR OVAL ANCHORED PLAIN STANDARD LIGHTING LAMPS.

Lamps of this type, of voltages 105 and below, 110, 120, and above, and also 220, may have double the limits of variation in the initial limits specified for their respective classes.

For lamps between 120 and 125 volts the useful life values shall be 95 per cent. of those given in the table, and for lamps between 126 and 130 volts the useful life values shall be 90 per cent. of those given in the table.

Lamps of other types of filaments shall give equivalent performances.

(*b*) VALUES FOR ROUND-BULB, TUBULAR, AND OTHER IRREGULAR TYPES OF LAMPS.

The individual limits for irregular types of lamps, such as round-bulb and tubular lamps, shall be twice the individual limits given in the body of the preceding schedules for regular lamps of corresponding candle-powers.

The individual limits for metallized filament and round-bulb prismo types of lamps shall be 15 per cent. above and 15 per cent below the mean candle-power rating, and 15 per cent. above and 15 per cent. below the mean total watts rating. The candle-power ratings referred to are the mean horizontal candle-power rating of clear lamps without reflectors.

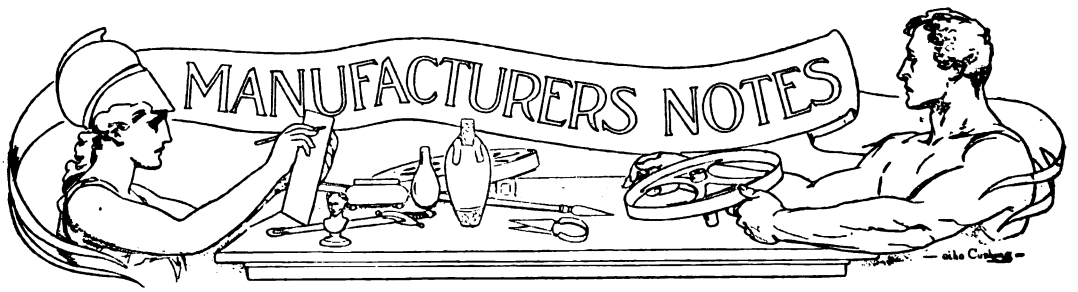
18. REJECTIONS AND PENALTIES.

The failure of the lamps in any package to conform to the specifications as to mechanical and physical characteristics, or to initial limits, may cause the rejection of the entire package.

The failure of the lamps to give within 90 per cent. of the values of useful life given in the tables may cause the cancellation of the contract.

Lamps which have not been used and are rejected under the terms of these specifications will be returned to the manufacturer at his expense, and no payment will be made therefor.

Prompt notice will be served upon the contractor of the test results on lamps that are rejected, or that fail to meet the specified requirements.



The Dale Company, of New York City, the largest manufacturers of gas, electric and combination fixtures in this country, and who placed the first wireless cluster on the market in 1898, having since received for same the highest award at the St. Louis Exposition, are meeting with great success with this valuable and useful little fixture.

As shown by the accompanying illustrations, it consists of but two parts, and can be installed in one-fifth of the time that it takes to install some of the other makes of wireless clusters. To install the Dale cluster, it is not necessary to remove and then replace the rings. The cap containing the cluster can be separated from the base by a half turn to the left, and by so doing it exposes the terminals, which are then easy of access.

In other wireless clusters, it is frequently necessary to remove the porcelain rings in the shell, in order to get at the terminal screws for fastening the wire, which not only takes much time and labor, but causes frequent breakages and consequent delays.

The fact that these clusters are approved by every board of fire underwriters, being electrically and mechanically perfect, and on account of their being great labor-savers, one of the largest corporations in this country, controlling many electric lighting stations, has adopted them as its standard fixture, and is now placing orders for from 3,000 to 5,000 at a time, and is installing them for its customers wherever wireless clusters are demanded.

One of the best proof of the labor-saving qualities of the Dale cluster was brought out recently, in the shape of a contest, at the office of one of the

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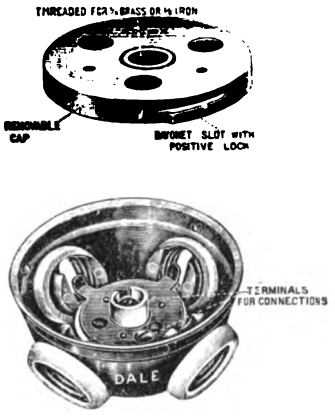
largest wiring contractors in New York City, at which time two equally expert wiremen were employed. One of them was given five Dale clusters to install completely, the other five clusters of an-



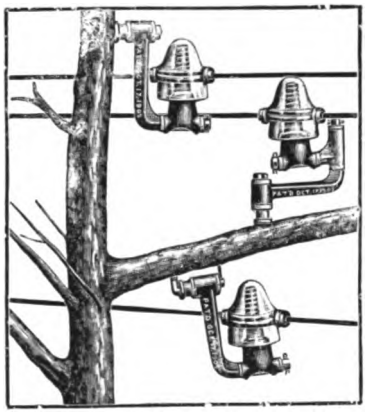
DALE WIRELESS CLUSTERS.

other make. The wireman with the Dale clusters installed all five before the other wireman had installed one of the clusters of the other make. As they were both four-dollar-a-day men, it did not take the contractor long to decide upon the cluster which he has since adopted in all his construction work.

Dossert & Company, of New York, have received what is probably the largest order for terminal lugs ever used on a single installation in this country. The material is for use in the wiring of the immense terminal building at Cortlandt, Church and Fulton streets, New York, of the Hudson and Manhattan Railway Company operating the tunnels under the Hudson River which have just been opened to the public. These terminals are all of the Dossert solderless type, comprising front connection, back connection, angle and swivel lugs and range in size from 2,000,000 C. M., down to No. 4 cable. Part of the order comes from the Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., and is for lugs to be used on their fuse blocks, enclosed type, 61 to 600 amperes. Approximately 1,000 Dossert solderless lugs are required for the switchboards and panelboards of these great twin buildings.

After a series of tests lasting over nine months, Harlin & Hollingsworth, of Wilmington, Delaware, have placed a large order with the Electric Cable Company, of 17 Battery place, New York, for their anti-corrosive compound, Voltax.

The month of March has, in the past, been looked upon with more or less apprehension by central station managers as the season of blustering winds, accompanied by broken and grounded outside lines; but since the advent of the Dunton Tree Insulator, these troubles have been almost entirely eliminated. The accompanying cut shows the various forms and applications of these tree insulators, which are so designed as to keep the light and power circuits rigidly in place and practically motionless, taking up by their swinging motion the waving and bending of trees and their branches in heavy wind storms. This company, Dunton & Feld, of Cambridge, Mass., has sold thousands upon thousands of these insulators, to electric lighting and power stations all over the country, and has yet to receive anything but the most favorable reports regarding their actions in taking care of this



DUNTON TREE INSULATORS.

heretofore "bug-bear" in connection with outside wiring.

Now is the time to get a report on the condition of your tree wiring and place your orders for these insulators, which will prove that "An ounce of prevention is worth a pound of cure."

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Murray Iron Works Company, of Burlington, Iowa, one of the largest builders of engines and boilers in this country, have just issued a most interesting and attractive thirty-eight page catalog No. 60, ilustrating and describing their line of water-tube boilers, which is complete with half-tones and diagrams, as well as cuts of their enormous works at Burlington. The catalog also contains numerous half-tone photographs of some of the principal lighting plants, city water works and large industrial and office buildings which are equipped with their boilers. The above company not only manufactures boilers and engines for every conceivable power purpose, but they also install complete power equipments for every service.

D. Van Nostrand Co., of 23 Murray street, New York City, are meeting with enormous success with the new Fifth Edition of Foster's Electrical Engineers' Pocket Book.

This new edition has been completely revised and enlarged, with four-fifths of the old matter replaced by new and up-to-date material. Mr. Foster has been ably assisted by the most eminent specialists in the various branches of electrical engineering in the preparation of this new edition, which consists of 1,100 pages, fully illustrated, and is unquestionably the most complete book of its kind ever published.

It is handsomely bound in flexible leather of convenient size for the pocket. It is a book that should be in the reference library of every electric lighting and power station in this country.

Weston Electrical Instrument Company, of Waverly Park, Newark, N. J., the largest exclusive builders of portable and switchboard direct and alternating current voltmeters and ammeters in the world, have just issued a new set of folders describing their Eclipse Direct Current Switchboard Voltmeters and Ammeters. Another circular describes the new Weston Alternating Current, low-priced switchboard instrument, another their swinging bracket switchboard voltmeters, and another describing their portable alternating current voltmeters and ammeters. All of these circulars are accompanied by their revised price list, and will be sent to any central station upon request.

Mr. Frank H. Gale, manager of the Publicity Department of the General Electric Company, Schenectady, N. Y., who is Chairman of the Exhibition Comittee of the National Electric Light Association, which is composed of Class D members, held a meeting of his committee at the Auditorium Hotel in Chicago on February 11, for the purpose of inspecting the facilities and general arrangements for the Convention Exhibition, with a view of outlining plans and other details in connection with his committee. These plans were formulated and presented to the Executive Committee at the meeting referred to on page 833 this issue, and comprehensive working arrangements have already been agreed upon.

Mr. Henry Floy, consulting engineer, of 220 Broadway, New York City, has just issued in book form, consisting of 327 pages and bound in cloth, a Compilation of the Records of the Colorado Springs Lighting Controversy. This was between the city of Colorado Springs, Colo., and the Pike's Peak Hydro-Electric Company, of the same city, and has become memorable because it decided for the first time, in a judicial way, three questions of importance to those engaged in the business of electric lighting. First: The meaning of the phrase, "An arc light of standard 2,000 candle-power." Second, the monetary damage accruing by the substitution of a 6 6/10 ampere series alternating current arc lamp, for an arc light standard of 2,000 candle-power. Third, the financial damage resulting from the failure to maintain the substituted lamps at their normal operating conditions. This volume is especially interesting and valuable to central station men from the fact that it contains the opinions of many of the leading experts of this country on questions of lighting, arc lamps and illumination. The book is most carefully prepared, and contains a complete record of the direct and cross-examinations of the experts, which are in themselves a set of questions and answers of the greatest value in central station practice.

Mrs. Frances A. McIntosh, formerly at the head of the Advertising Department of the Norton Company, of Worcester, Mass., has just been appointed manager of the Advertising Department of the Buffalo Forge Co., the Buffalo Steam Pump Co. and the George L. Squier Manufacturing Co., of Buffalo, N. Y. These companies are under one ownership, with a capital of one million dollars, and Mr. William F. Wendt, the president, has made no mistake in securing the services of Mrs. McIntosh, who is in a class by herself as a publicity manager.

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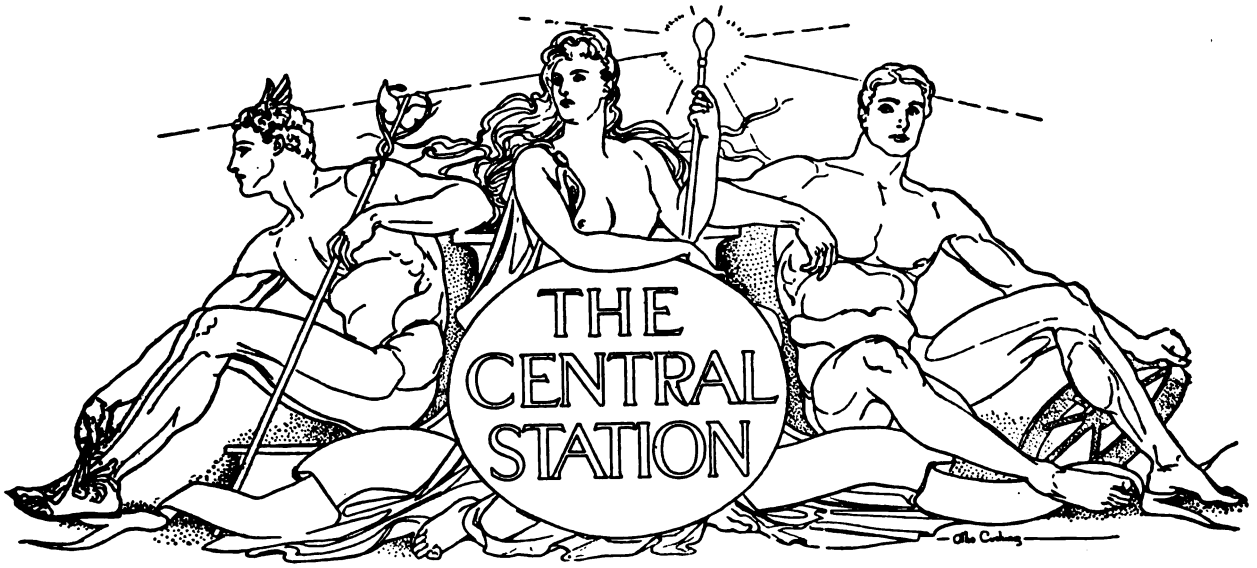

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, NO. 10. NEW YORK, APRIL, 1908. ISSUED MONTHLY.

Central Station Light, Heat, and Power Principles

BY NEWTON HARRISON.

Station Capacity.—That which is called station capacity may be considered from several standpoints. It is the custom to govern the definition by reference to the accepted lamp capacity or the aggregate of station service. Aside from this presumption, it is best to present the idea of station capacity as follows:

1st. The total capacity of the central station in kilowatts.

2nd. The total capacity of the central station in lamps.

The total capacity of a central station is generally given with its including factor of overload. In other words, the rated capacity may be, for instance, 1000 K. W., but the total capacity with the generators and engines strained to the limit might be 1250 or 1500 K. W. A case in point may be presented, showing the total output of a station in power and lamps along the lines indicated.

Capacity of Station in Kilowatts and Lamps.

1. Normal capacity of station in kilowatts = 1000. Voltage 115.

2. Capacity under stress of overload in kilowatts = 1250. Voltage 115.

3. Normal capacity of station in 3.5 watt 16 cp. lamps = 1,000,000 ÷ 56 = 17,857.

4. Capacity under stress of overload in 3.5 watt 16 cp. lamps = 22,321.

The problem still further reduces itself down to a consideration of the character of lamp employed for the purpose of lighting, and the degree of efficiency exhibited by it in watts per candle power.

Lamp Capacity of a Station.—Aside from the use of power implied by a central station, the greater part of the proposition is that of supplying electricity for lighting. Lighting may not be sufficiently in character to be entirely comprehended under the head of incandescent, and for that reason the lamp capacity of a station may be subject to criticism unless the character of the lamps or lighting under consideration be particularly specified.

Kind of Lighting from Central Stations.

1. Incandescent, with lamps in use of the ordinary corban, metallized carbon, Tantalum and Tungsten type.

2. Arc, with lamps in use of the enclosed arc, open arc and flaming arc type.

3. Nernst lamps or other rare oxide types.

4. Mercury vapor of the Cooper Hewitt model.

5. Vacuum tubes of the Moore type.

Though it is evident that the degree to which lamps of different types are employed may be comparatively well known in special instances of cen-

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tral station practice, it is also evident that it would be only an approximation to state the percentage of one or the other in use in the majority of instances. Yet ordinary lighting practice is of such a character in large cities, that it is possible to arrange a fair average, elastic enough to permit of exceptions to be understood with respect to the figures quoted.

Percentage of Type of Lights in Service on Station Lines.—Incandescent lamps, from 60 to 80 per cent of the light load. Arc lamps, from 10 to 30 per cent of the light load. Cooper Hewitt, from 5 to 10 per cent of the light load. Moore, from 5 to 10 per cent of the light load. Nernst, from 2 to 5 per cent of the light load (depending largely upon the place of lighting in many instances). The power item is variable, as is the lighting, but this does not imply any considerable difference between the percentage utilized in cities agreeing in the majority of particulars as to manufacturing or industries of a general character. In other words, the central station supplies power for light and for motors, the two demands representing percentages that can be roughly estimated if the city or town does not partake of extraordinary characteristics. For instance, New York, Philadelphia, Boston, Chicago and Cincinnati are types of cities alike in many respects though different in other features which can hardly be said to affect the central station service to such a degree that the demand for current for light, heat and power is essentially different. The number of theaters, halls and street lights might differ simply because more amusement is sought at night and consequently more people are out late, but the greatest item of power is necessarily consumed in connection with the incandescents employed for lighting.

Station Capacity Governed by Efficiency of Incandescents.—The fact that lamps are not of the same efficiency, is a powerful factor in determining the real capacity of a station as a source of light. For instance, with only arc lamps, a station would produce a certain candle power if all its energy were diverted into this channel. If only incandescent were used, however, it would be absolutely necessary to state the type of lamp or the rating in watts per candle power. It is admitted that three sets of figures are possible with arc lamps, as may be noted from the following comparison:

1. Advantage of lighting with flaming arcs productive of the greatest amount of candle power per unit of power.

2. Advantage of lighting with ordinary arc, productive of the next highest amount of candle power per unit of power.

3. Advantage of lighting with enclosed arc productive of the lowest amount of light per unit of power.

Though the amount of power per candle power is greatest with the enclosed arc as regards consumption, it is also evident that other advantages are obtained which make it desirable to forego economy and benefit in other directions.

If the capacity of a station is measured wholly on the basis of the number of incandescent lights it could supply, it would be more instructive and interesting to take an hypothetical case to illustrate the point in view, namely: the value of low watt lamps in future station practice.

Capacity of a 1000 K. W. Station With Various Lamps.

16 cp. carbon lamps of 3.5 watts per cp. total number of lamps = 17,857.
16 cp. metallized filament of 2.5 watts per c. p., total number of lamps = 25,000.
20 cp. Tantalum lamps of 2 watts per cp., total number of lamps = 25,000.
32 cp. Tungsten lamps of 1.25 watts per cp., total number of lamps = 25,000.

The interesting feature presenting itself in an examination of the conditions prevailing in a station capable of extending its service without greater internal expense, would be the certainty of dividends on stock issued, or the greatly increased dividends if the stock has already been earning a satisfactory returns. In other words, the power of a plant to do much more business, with merely a change in the lamp employed is the simplest of all solutions to the problem sometimes discussed by station managers of how best to make a plant pay. An examination of the figures obtained above will readily illustrate the difference between the returns in light obtained by the old lamp at its best and the modifications made in the carbon subjected to new treatment. In addition, the value of electricity as a light producer is readily ascertained, when it is utilized in lamps of newer make in which carbon has been entirely discarded.

Total Candle Power Obtained With Different Types of Lamp in a 1000 K. W. Plant.

Carbon filament lamps, 3.5 watts, total cp. = 285,714.

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Metallized filament lamps, 2.5 watts, total cp. = 400,000.

Tantalum filament lamps, 2.0 watts, total cp. = 500,000.

Tungsten filament lamps, 1.25 watts, total cp. = 800,000.

The tremendous difference in candle power manifested by lamps consuming about the same amount of power is an object lesson to central station managers of large or small plants. The financial future of a plant is more apt to be found in the use of an efficient lamp than additional expense in installation for the purpose of extending the service of the plant. As an illustration of this point, it may be noted in the figures given, that carbon as compared with tungsten lamps consume nearly three times as much power. A customer on this basis can have the choice of two things: either use more lamps and have the same monthly bill for current, or use the same number at reduced expense.

Central Stations Not Selling Light.—The fact of interest to be deduced from calculations of this character is to the effect that central stations are not selling light but power. The problem of obtaining the greatest possible quantity of light from the power consumed lies largely with the consumer and not the station. But it is not only consistent with good station practice, but sound business sense to use lamps by means of which customers are able to get the maximum of light from the mimimum of power, other things being equal. The advantage to the customer is easily recognized, when lamps of low watt rating are employed instead of those of an older type. The question involved is that of balancing up the additional cost of the new lamps against the saving in power attained by their use.

Cost of Lamps and Saving in Current.—In a case where 1000 lamps are used to supply as much candle power as was formerly supplied by lamps of a less efficient make, the following items enter into the considerations involved:

1. Extra cost of 1000 lamps as compared with the old type just removed.

2. Value of the power saved per month or year with new lamps of high efficiency.

3. Cost of breakage, whether greater, less or the same as presented by former conditions.

Comparison of Equal Candle Power With Electricity and Gas.—The point of interest developed in connection with central station problems of this character is the comparative cost of an equal quantity of light with gas and electricity. In New York City gas is sold at one dollar per 1000 cubic feet. At a consumption of 5 cubic feet per hour per 16 candle power tip, it is a simple matter to estimate 200 hours of service of 16 cp. or a total of 3,200 candle hours. On this basis it is not a difficult matter to estimate the cost of electricity for an equal quantity of candle power hours.

At ten cents per kilowatt hour, the cost of light will depend entirely upon the selection of the lamp to be used. If a tungsten is chosen, a 32 cp. taking 40 watts per hour would cost the following for 3,200 candle hours: It would burn $3,200 \div 32 = 100$ hours to begin with. The cost would be that of 100 hours with 40 watts consumption per hour, or $40 \times 100 = 4,000$ watt hours $= 4$ kilowatt hours. At the prevailing city rate of 10 cents per kilowatt hour it is evident that 4 hours would cost $4 \times 10 = 40$ cents. With a tungsten lamp it is easily proven that gas lighting at standard rates is considerably dearer than electric lighting in the ratio of 100 cents to 40 cents, thus proving what could hardly have been expected ten years ago.

Tendency in Lamp Construction.—The tendency critical observers have not failed to notice in lamp construction, is the drift in the direction of non-carbon filaments. The advantage of this change of base has been manifested in a variety of ways. There is no reason why other substances should not take the place of existing materials provided the advantages thereby gained are of a character making the change acceptable. For instance, the point to be noted in modern lamp construction is the effort to obtain a higher temperature with the same quantity of energy. The governing factors assume the following form with respect to incandescent lamps in general.

1st. A higher temperature to gain more light.

2nd. A larger radiating or light giving surface.

3rd. A more indestructible form of matter for the filament.

4th. A diminished energy consumption for the light given.

The main object in advancing certain forms of light producing filaments aside from the advantages they naturally possess is to see the effect upon the public not only as cheaper sources of light, but whether the character of the light is acceptable apart from economic reasons. Inventors sometimes run up against a snag right here, they produce an excellent addition to science, but sometimes their invention, particularly if in light, fails, because of the esthetic taste which antagonizes it.

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Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability for Death or Injury from Electric Current, Continued—Duty and Liability to Licensees and Trespassers—Employees of Other Companies

The question of liability raised under these conditions is as to whether or not an electric company is liable to the employee of another company who is on the electric company's pole or is handling its wires for purposes connected with his employment. As a general rule it may be said that the liability to this person under those circumstances depends not so much upon whether there is negligence upon the part of the electric company as it depends upon whether the person injured has a right to be where he is when injured. Of course the elements of negligence and contributory negligence are important if the man has a right to be where he is when injured, but the first question to be decided is, had he a right to be in contact with the wires of the electric company? If he had that right then the second question is, Ought the electric company to have foreseen that a person rightfully in that position was liable to come in contact with its wires and ought the electric company to have foreseen that if he did come in that contact, he would be injured? Having determined that the electric company was negligent in not having provided against the liability for injury under such circumstances. that is, in not having foreseen the likelihood that a person would come in contact with its current, the next question that arises is, was the person killed or injured himself negligent, that is, should he by the exercise of such care as ordinarily prudent persons are wont to exercise, to have foreseen his liability to injury and have avoided it? If it is determined that he was not guilty of contributory negligence, then the electric company may be liable; if it is determined that he was guilty of negligence which contributed to his injury, then ordinarily the electric company is not liable. If it is determined that the electric company did not neglect any duty upon its part, then it would not be liable; but if on the other hand it should be determined that the electric company did not take such precautions for the safety of persons liable to come in contact with its wires as it should have taken, then it would ordinarily be liable. With this statement of the general authorities governing this field, let us examine some of the cases which are pioneers in the law on this subject.

Quite an important case is that of Newark Electric Light Co. vs. McGilvery, 62 N. J. Law, 451, 41 Atl. Rep., 955. In this case it appeared that John McGilvery was employed as a lineman by a traction company and was engaged in taking down a feed wire belonging to that company from poles in a public street. While doing this, the evidence showed, that the feed wire fell and broke a wire of an electric light and power company which was strung upon the same poles; that the end of the broken wire lost some of the insulation as it fell to the ground and that it lay upon the ground; that the end of it nearest the power house of the electric company was tested and was found to be dead; that this end was subsequently handled by employees working with McGilvery, without injury. Subsequently he was directed by the foreman in charge of his gang to perform some service with the wire, and received a shock therefrom which caused his death. It further appeared that the short circuiting caused by the fall of the wire melted out the fuse in the power house of the company and that subsequently and between the time the wire was tested and handled by others and the time when it was handled by McGilvery the fuse was replaced, and the question was raised whether the electric company should have learned what the cause of the melting of the fuse was before inserting a new fuse, not having been responsible for the fall of the wire and not having been negligent in any manner in its position where the deceased could take hold of it was it negligent in again establishing the circuit without determining what was the cause of the

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short circuit? We shall quote quite liberally from this opinion owing to the unique features in the case and among other things the court said:

"In the first place it is plain that the company was in no possible sense responsible to deceased for the fall of the wire. Such companies using in business wires to carry a subtle and invisible power highly dangerous to life, must, although authorized to stretch such wires along poles in public highways, exercise a very high degree of care for the safety of those who may be thereby exposed to danger. In that regard they owe a duty to everyone using the street in the ordinary mode, and if from insufficient supports or from causes which a high degree of precaution would have prevented, the wires fall in the street and do injury, they are doubtless responsible. But in this case the wire fell, not because of any act or omission of the company, but because deceased and those associated with him broke it down. Whether the breaking was intentionally done or was produced by negligence, or mere accident, the company is in nó way responsible to those who broke it for any injury to any of them, at least for any injury which was the direct result of the breaking.

"In the next place, the death of deceased was not the direct result of the fall of the wire. If the exposed end of the wire had fallen upon deceased while it was still charged with a dangerous current, and by such fall the current was passed through his body to his injury, it would be impossible to find any negligence chargeable to the company. A like result would follow if the wire after the fall, continued to be charged with the current and, upon his picking it up, the current was passed through his body to his injury, at least until the company had some notice of the condition of the wire. In each case the injury would be attributable, not to the company, but to those who by breaking the wire had made it a cause of injury. But in the case before us the jury might find, as we have seen, that after the fall of the wire, it became inert and innocuous and could be and was handled with impunity. If that be so, the death was the result of the turning on of the current again by the insertion of the new fuse, and the exposition of the wire occasioned by the fall was only the means by which the injury was inflicted.

The real question, therefore, is, what duty devolved on the company, under the circumstances, with respect to the insertion of a new fuse and thereby renewing the current through this wire?

The evidence does not make clear that the melting of the fuse gave notice to the company that the wire was broken and grounded, for the expert evidence is that such melting might be caused by a short circuit resulting from a crossing of the wires, as well as by the grounding of a wire. Such melting, therefore, only gave notice that one or the other cause had operated.

To persons unconnected with the breaking of the wire and using the street in the ordinary mode, I have no doubt the company owed a duty to refrain from sending a current through the wire until it was ascertained that it was safe to do so. But in my judgment one who had participated in breaking down the wire cannot charge the company with that duty until he has given it notice of the broken wire and its being grounded.

If it could be claimed that, in the absence of proof that this current was carried on wires which might cross, the jury might find that the melting of the fuse gave notice that one of the wires was broken and grounded, a like distinction in the duty devolving on the company exists. As to persons unconnected with the breaking of the wire and traversing the street in the ordinary way, its duty would be to refrain from turning on a current until it had been ascertained it was safe to do so. But to one who, like deceased, had participated in breaking down and exposing the dangerous wire and who thereafter intermeddled with it, the company owed no duty except to refrain from wilful acts to his injury. The subsequent handling of the wire which was exposed by the breaking and fall, was a mere continuation of the act which had broken the wire and caused it to fall. With respect to that wire, the gang of which deceased was one were either trespassers or at the most licensees, and the measure of duty to such is that above stated."

Liability for Injury by Electric Wire to Policeman Engaged in Detective Work

The defendant in error was a policeman in Greenville, and, suspecting that persons were gambling in a room in the upper story of a building in the city, he, on several occasions at night, ascended to the roof of an adjoining one-story building in order that he might see into the suspected place through its windows. After he had done this once or twice, and had seen gambling going on, he stated his action to the mayor, and expressed the opinion that it would be best, before making arrests, to continue

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his watch in order to identify a greater number of the persons thus violating the law, to which the mayor assented. He again went upon the roof at night, and, in moving about, he came in contact with and was burned by an electric wire which belonged to the city, and was used in connection with its electric lighting plant in supplying light. This wire extended north and south with and near to a fire wall between the building on which the plaintiff was and an adjoining one, and ran down the partition wall between the two at one end. The insulating material upon it had become defective to such an extent as to render contact with it dangerous. The city operated its plant at night, its wires not being charged with electricity in the daytime, except on a few rare occasions. No way had been provided by the owner of the building upon which plaintiff went for getting upon it, and plaintiff reached its roof by climbing upon a fence in its rear and then passing over the top of a low adjoining room. Access to the roof could also be had from the gallery of a nearby hotel across the walls and roof of an intervening house. It was shown that at times during parades and like occasions, people had gone upon these roofs in the daytime, but not at night. Plaintiff had no invitation or express permission from the owner of the building to go upon it. We do not doubt that it was the duty of the city to the owners of the buildings, their servants, employees and anyone else, who may have had a legal right to go upon the roofs, to exercise proper care in maintaining the wire upon the partition wall to protect them against injury from contact with the wire. Plaintiff was invested with none of the legal rights which pertained to the ownership of the building nor an interest therein. He went upon it for purposes of his own, and not in the interest of the owner. If he was not a trespasser, he certainly was no more than a licensee under an implied license. If he be regarded as such a licensee, this would not clothe him with any legal right in the use of the building. It would merely relieve him of any imputation of being an unauthorized trespasser. Though his act be regarded as lawful, or even praiseworthy, he nevertheless was using the premises of another for purposes of his own, without any legal right in himself which entitled him to object to the condition in which the owners maintained them.

The city, it appears, maintained its wire partly upon the wall of buildings belonging to others, and partly in the space above such wall. This was the affair of the city and the owners of the property. We must assume that the wire was there lawfully. As to the plaintiff having no right with respect to such wall and such space, they are to be regarded as the premises, not only of the owner of the lot and the buildings, but of the city. Neither was under legal duty to keep them safe for the plaintiff. If the roof had fallen in with plaintiff, would any one contend that the owner would be liable to him? In what does the attitude of the city differ? It was not keeping its wire in a public place, where all had the right to go, or might be expected to go, but on private premises, which we must presume it had required some right or permission so to use, and was under no duty in keeping its property there to one like plaintiff who went there without invitation or inducement from any one interested in such premises. Plaintiff's official character does not affect this question. The city, as owner of its light plant, occupied the position, so far as this case is concerned, of any other proprietor, and we know of no principle which makes it the duty of a proprietor to keep his premises safe for the use of such officers when they have occasions to go thereon in pursuit of violators of the law; nor did the conversation with the mayor add anything to plaintiff's rights. The mayor did not instruct or invite the plaintiff to go upon the house, but merely agreed with him in the plan which he himself had conceived. Besides, the mayor was not the representative of the city as owner of the light plant, and, lastly, such an assent as this transaction might employ, if given by an owner himself, would be no more than a mere permission or license authorizing the licensee to enter the premises in their existing condition and carrying no duty to alter them for his use.

We conclude that defendant in error has no right of action against the city, and the judgment of the district court and of the Court of Civil Appeals will be reversed, and judgment will be entered for plaintiff in error.

City of Greenville vs. Pitts, 107 S. W. Rep., 50.

Complaint was filed in the United States Circuit Court in New York in The Westinghouse Electric & Mfg. Co. against the Beck Flaming Arc Lamp Co., of New York, for infringement of the Bremer patents covering the manufacture of flaming arc lamps. Similar action will shortly be taken against other infringements, as the Bremer patents owned by The Westinghouse Electric & Mfg. Co. are basic on this type of lamp.

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Effect of Light Upon the Eyes

By Dr. H. H. Seabrook.

It is manifestly impossible to know what effect light may have upon the eye without knowing something about the structure of the eye. In the schematic anterior-posterior section of the eye presented in Fig. 1, and the description thereof only enough of the anatomy is given for an understanding of the references which follow later.

The transparent anterior part of the eye, the cornea and the lens behind it, are the main factors in focusing rays of light upon the membrane lining the eyeball, the retina, forming within it an inverted image of any object toward which the eye may be directed. The sensation from this image is carried by fibers in the retina and optic nerve to the brain and there interpreted according to education and experience. The posterior layer of the retina

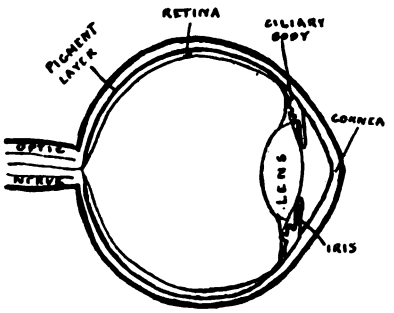

FIG. 1.—SCHEMATIC ANTERIOR-POSTERIOR SECTION OF THE EYE.

consists of cells filled with pigment which absorbs light. The whole process which occurs in the retina under the action of light is one of disassimilation, and repair takes place in the dark. The pigment layer extends forward over the ciliary processes and forms the posterior layer of the iris. The ciliary processes are folds rich in blood vessels and nerves. They furnish a low grade nutrition for the lens, and their veins must remove waste tissue, including pigment disassociated from the cells by the action of light; when much work of this sort is required the process may be painful. The ciliary body consists of the ciliary processes and the ciliary muscle, which latter contracts and allows the lens to become more convex so that near objects may be seen. This process, called accommodation for near objects, may result in pain about the ciliary region from strain of the ciliary muscle when near use of the eyes is too long continued. As an optical instrument the eye is defective. It has chromatic aberration, spherical aberration, and other forms of irregular astigmatism, usualy measurable, and regular astigmatism, and other refractive errors peculiar to the individual. These errors when not corrected cause irradiation of light with the eyeball, with consequent irritation, because rays are not properly focused. When eyes are corrected with glasses, excessive and irregular action of the ciliary muscle is often removed, but since irradiation of light is bettered and glass filters or stops the chemical rays, the ones injurious to eyes, it is difficult to separate eye strain due to light from that due to accommodation.

That the delicate retina is not often badly injured or actually destroyed by sunlight must have caused comment among early observers in physiological optics, as the difference between heat, luminosity and chemical action from light was long ago recognized. The discovery of the composition of white light, the development of photograph, the oft mentioned similarity of the eye and the camera, and the recognition of the ultra-violet rays, evidently set men thinking anew about the natural defences of the eye against such a powerful destructive agent as light. There are three methods of protection plainly in evidence. These are partial or complete closure of the lids; the action of that circular curtain, the iris, especially when its central aperture, the pupil, is narrowed by exposure to light, and lastly, the frequent movement of the eyeball so that any one portion of the retina may not be fatigued from too long exposure to white or colored light, Anatomists exaggerated the power of endurance of the pigment layer in the absorption of light, yet even then it was hard to see how the retina escaped as well as it did.

In 1845 Brücke tried the effects of ultra-violet rays upon tincture of guiac, and after passing through the media of the eye of the ox, and found that these rays were largely absorbed by the lens and to a less degree by the other media and the cornea. Donders, eight years later, concluded that the lens had no power of absorption of ultra-violet rays, since the fluorescence of quinine solution from these rays was apparently no less when sunlight was filtered through the lens of the pig, sheep, or ox than through glass. Ultra-violet rays do not pass through glass without loss and de Chardonnet showed later that different results occurred according to species. The human lens absorbs spec-

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tral light at the H line and absorption is complete at L or M. Helmholtz, influenced by Donders, concluded that the absorption power of the animal lens was small, but when experiments were made upon animals in which the lens of one eye had been removed and that of the other left, and the electric light was brought into use, as well as sunlight, and the results upon the different eyes, as observed by many careful men, tabulated, no doubt was left as to the results. In 1904 Birsch-Hirschfeld took up the matter after nearly twenty years' time had elapsed since other investigations but with most painstaking work was able to do little more than confirm principles already established. Certain things seem worthy of mention, although only a brief general review of the results is possible here. The damage to the external parts of the eye, including the lens, is directly proportionate to the strength of current and length of exposure. With a current of three to four and a half amperes from a Finsen lamp, with the iron cooled by water so that the lamp was not hot to the skin, chemical changes were produced in eyes in four or five minutes. These were a certain puffiness and change of color of the anterior coats except the cornea, with slight cloudiness of the cornea and shedding of cells covering its posterior surface, and congestion and discoloration of the iris. The layer of cells lining the anterior capsule of the lens, from which its fibers are formed, also showed injury. Inflammation followed twelve to twenty-four hours after exposure and subsided in four or five days, although eyes were not normal for four or five weeks, even when they escaped permanent damage. The protection from the lens varied greatly in different individuals. Exposure to ultra-violet rays caused damage to the ganglion cells of the retina in one-half to one hour in eyes without the lens and with a longer exposure in eyes retaining the lens. With repeated exposures, even if the chemical light was not very intense, cataract would be formed. This opacity of the lens would then be permanent. Spectral rays of sufficient intensity cause damage, but the blue, and still more the violet rays are the really harmful ones.

Disintegration and disassociation of the cells in the pigment layer, occurring from exposure to light, are at a minimum in yellow light. A natural suspicion that heat rays cause damage to the eyes has never been confirmed; discomfort may, perhaps, be caused by them, but no tissue changes.

Injuries to the eye occur to the human race from both natural and artificial light. The best known of these is snow-blindness, due to exposure to reflected light from snow in a clear and rarified atmosphere. Chemical rays are absorbed by atmospheric dust, and the "yellow sunlight" is safer for eyes than the clear white light of the sun. To the objective signs given previously, as seen in rabbits' eyes exposed to the Finsen light, are added gritty sensations, from the inflammation of the lids, and impaired vision, or complete blindness. The same results follow exposure to strong electric light, and about the year 1890 medical journals had many reports of such cases due to the arc light. Such results still obtain, but as they occur mostly among workmen who know that the damage to the eye usually causes little if any permanent impairment of sight, medical advice is not frequently sought. Those exposed have learned how to protect their eyes better than formerly, and no doubt such cases occur proportionately less often than formerly. Exposure to direct sunlight is so evidently injurious that it is avoided, although occasionally bad results occur from recklessness in viewing an eclipse. A permanent defect in the center of the retina, just where the sun's image was focused, is often the result. In persons struck by lightning or where exposed to very bright electric flashes, eye troubles similar to those above noticed may occur, and an opacity of the lens sometimes results.

The severe injuries to the eyes from light already mentioned have but little practical bearing upon the work of illuminating engineers. No one expects the demand for brilliant light upon streets or in public buildings to be ignored, and the flaming arc lamps, Moore tubes and Welsbach street burners, each in its particular Sphere, to be replaced by kerosene lamps. There are many other things to be considered in lighting large areas beside the eyes, which may be protected from too powerful light fairly well by frequent changes in their position and consequent rest to the exposed portions of the retina.

Illumination for near work, however, is in a most unsatisfactory state. Our country leads the world, apparently, in the brilliancy of its artificial illumination and certainly leads the world in ocular exhaustion, discomfort and congestion.

When gas came into general use these troubles began to increase, and a further increase was in evidence as the incandescent electric lamp came more and more into fashion. Both here and abroad, oculists agree that the kerosene burner is the least harmful artificial illuminant. They might leave the word artificial out with propriety, for no damage has been traced to kerosene light. The most

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satisfactory light is, no doubt, daylight (not sunlight) a few feet within a closed window on a bright day. In this light, finer lights and shadows and delicate colors may best be distinguished by healthy eyes. A greater distance from the source of light diminishes vision, and even taking away the protection of the window glass, causes more dazzling and decreased retinal endurance. The adaptability of the eye is small for increased illumination, and the limits of increase of vision with stronger light is within the medium limits of illuminaton. The light should come from the rear and left and fall upon the object. If the latter has a glazed surface which reflects white light, fatigue is more rapid than with a dull surface, for below the surface of objects chemical rays are absorbed and color and visibility is due to that portion of the white light which is not absorbed but returned to the eye from below the surface.

Analyses of light, as published, are difficult to comprehend by one who is ignorant upon the subject. Daylight, or sunlight, is a variable standard to take without further definition or explanation of the conditions. Meyer's analysis, as given by Cohen, has violet in the electric (arc) light as .3 to daylight 1., and as given by Staerkle, 1. An analysis published by the Acetylene Company gives for the violet in the arc light 1. to 1. for sunlight. Staerkle gives, for gas, violet .1; Cohen, .3; the Acetylene Company, 1.15. Let us suppose that one table, giving the kerosene burner as very weak in violet rays, is correct, and another with ostensibly the same standard, omitting kerosene, is correct in giving the electric incandescent lamp what is meant to be the discredit of weakness in violet rays as compared to the other illuminants; we must then look for contributory causes which have caused the incandescent lamp to give rise to more chronic eye degeneration and disturbance than any other light used for near work. Acetylene may be thrown out on account of lack of opportunity for much damage. The image of the brilliant filament of the incandescent lamp, with its concentration of light, must harm the retina more than the more diffuse images of flames; the benefit from ground glass globes for this light, when the eyes are exposed to its direct rays, must be partly due to diffusion of the light. Without ground glass, this light is more steadily brilliant than kerosene, gas, or the gas mantle burner, and there is less chance for retinal recuperation. Ground glass reduces all the rays of the light about twenty-five per cent. In searching for other causes of trouble, we note that the movable kerosene lamp may be, and is usually, placed in a good position to illuminate the object, while the incandescent electric lamp is usually not well placed, often in offices being rigidly fixed so that either the eyes must be subject to direct light, or the head must be bent forward for work, congesting the eyes. No amount of green on a tin shade will correct this improper permanent position of the lamps. Again, we notice how very thin the glass bulb of the incandescent is compared with the lamp chimney, and since glass of five millimeters thickness absorbs twenty-nine per cent. of the chemical rays of sunlight at an angle of 60 degrees (Hankel), we conclude we have another element of trouble, as chemical rays are absorbed by glass in proportion to its thickness.

The Welsbach mantle changes the ordinary gas flame, with its marked excess of red, to a cold light, deficient in that color. It is less irritating to some eyes than other lights, but more irritating to others.

Many substances absorb chemical rays and allow luminous rays to pass. For practical purposes there seems no need to consider any of them except glass as a protection for the eyes from the intrinsic brightness of too intense light. Neither does there seem any question that yellow is the color to choose to conserve or improve vision and protect the eyes from the chemical action of light. Globes may be used of pink, orange, red, or green, as desired, when the light may be dimished in luminous quantities. It is best to choose for protective purposes that shade of yellow which appears in the best ray filters or is shown in the glass used for modifying the light of developing rooms for photographic plates. This amber yellow may be darkened by a brown admixture for weak or diseased eyes, or unusual light exposure. It is difficult to manufacture without imperfections, and the supply slowly follows the demand.

That the study of illumination for practical purposes is difficult no one will deny. The difficulty of conveying knowledge about light, even if one possesses it, must be great, for there is no definite language, as of medicine, for instance. Newton first separated light into primary colors, and he also advocated the corpuscular theory of Descartes; and after more than two centuries we use Newton's language and speak of chemical rays in order to be understandable, and compound such sentences as "Since the wave lengths at the violet end of the spectrum are but half the length of those at the red, twice as many chemical rays as heat rays, from

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white light enter the eye during the same period of time." When we speak of light in general, we usually mean light with infra-red, spectral and ultra-violet effects. Light rays may mean the visible spectrum, or the luminous yellow. The expression primary colors has just been used. It meant then the seven colors to be distinguished in the spectrum by many eyes, or the six that can be recognized by the others. It is frequently applied to the fundamental pigment colors, red, yellow and blue, from which all other pigment colors may be produced by mixing; or the fundamental spectral colors, red, green and violet.

Illuminating engineers are not entirely satisfied with standards of measurements of light; they would be still more confused if the visual standards which oculists have used for many years should be presented to them. Vision for distance only has been considered, and the apparent contradictions in facts, the long descriptions of investigations by Germans, often followed by conclusions entirely at variance with the premises; the conclusions of others, especially Americans, upon no premises at all; make "laws," as they were formerly called in these studies, rather difficult to formulate. In the present instance, you are asked to believe, what many of you already know, that the desire for intensity of light has been already overdone as regards the good of the eyes.

As regards deductions to be drawn from this paper, they are not difficult. Lights weak in chemical rays are better suited to the eyes than others. Present lights may be improved by attention to position, including the distance of the source of light from the eyes, as measured by the course of the rays, and protection of eyes by glass properly colored.

Take the spectrum of daylight through a window, and that of kerosene, argand, Welsbach and incandescent electric lamps, from just where you would sit to use them for near work, see what shade of amber yellow glass it takes to cut off the blue and violet rays, and you will find under those conditions the kerosene burner at one end of the list and the incandescent filament at the other.—*Read before the Illuminating Engineering Society.*

The Electric Cable Company, of 17 Battery place, New York, whose plant at Bridgeport, Conn., was partially destroyed by fire, announce that they have made arrangements which will permit of filling all orders received for their various products, including Voltax, the transparent protective compound; rubber covered wires; weatherproof wires and cables; magnet wire; annunciator and office wire, etc.

Pending adjustment of insurance details, the company will make no announcement of its place for re-building.

National Electric Light Association Convention. Chicago, May 19, 20, 21 and 22

The thirty-first convention of the National Electric Light Association, which will be held at the Auditorium Hotel in Chicago, on May 19, 20, 21, and 22, promises to be the most successful of the many successful conventions held by this Association, which is the most representative of the interests of electric lighting and power stations in the world, representing as it does the interests of five thousand electric lighting and power stations, with a capital invested of over $800,000,000. The Electrical Exhibition, which will take place in the large hall on the top floor of the Auditorium, and which adjoins and connects with the meeting room, promises to be one of the most attractive and representative exhibitions of apparatus and supplies for the operation and maintenance of electric lighting and power stations which has ever been made at any convention. Already over half of the exhibition spaces have been snapped up by representative manufacturers, and undoubtedly long before the convention opens, every booth in the Exhibition Hall will be taken. The exhibitors have been restricted to Class D members of the Association, which membership is made up principally of the representative manufacturers and dealers in central station apparatus and supplies.

The Tungsten lamp is to play a prominent part in the illumination of the Exhibition Hall. This is appropriate to the times, and will prove an excellent demonstration of the color qualities of this new lamp, which is now receiving so much attention from central stations all over the country. The color scheme is receiving a great deal of attention, as it is the desire of the Committee to make the exhibtion attractive, not only from a commercial standpoint, but also from the artistic standpoint.

Notifications regarding hotel accommodations, transportation, etc., will shortly be sent out to members in special circulars. Hotel accommodations may be engaged from now on by communication with the Chairman of the Electric Committee, Mr. H. E. Niess, 139 Adams St., Chicago.

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No commissions are allowed on advertising contracts or subscriptions.

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Electric Versus Gas Lighting

The proposition is not as startling to-day as it would have been some ten or fifteen years ago, that electric lighting can be made cheaper than gas for domestic use. No miscomprehension need arise on the head of this statement, for the difference between the sale of electricity as a public commodity, and the utilization of it for light are sufficiently explicit to need no further definition.

That which is termed an electric light differs in so many respects from the types of light-producers used in conjunction with gas, that there is hardly any point of common interest between them, except the incandescence of a medium which throws out the light when a sufficiently high temperature is produced. As is well known with substances upon which the heat of a flame plays, they must possess qualities in virtue of which the heat is not radiated too rapidly, the correct incandescence is attained and the cost of the light producing element is not too high to forbid its general use if it prove efficacious.

The same is true in certain respects, if not all, as far as a new filament for an electric lamp is concerned. When it is known that a new lamp has been placed on the market, the inquiries proceeding from the critics and experts are of a purely rational character, such in fact as may be gratefully received by those interested in the enterprise. They want to know whether it will give more light for unit of power, whether it is more friable than other filaments, whether it is expensive in comparison and the number of hours it can be depended upon to give full candle power.

The public can hardly understand the importance of good work in this direction to themselves. They do not seem to fully understand the dollar-and-cents relationship existing between the electric current as they pay for it and the lamp which receives this form of energy and produces light. Strange to say, in all instances the layman will immediately inquire with respect to a new gas light, as to whether it gives a better light and takes the same amount of gas or takes less. The cost of gas per thousand cubic feet has no poetry associated with its presentation, and for that reason at least, the inquiries are apt to be more pertinent in regard to the actual gain to the ordinary consumer.

With electricity now in the vanguard of successful commercial exploitation, the public have become accustomed to the declarations made to such an extent, that the value of a kilowatt hour has been legally defined in many legislatures, even though the law givers themselves, in confessing the truth, would honestly say that their opinions as to its real meaning are rather indefinable. As a definite amount of electrical energy costing a certain amount to produce it is only too easily definable to its producers, the central station men. They have long realized that its cost must not be prohibitive to the public purse, and have therefore developed the field of electric lighting sufficiently to meet to in more than an adequate degree the call for cheap electricity and good service.

Any sensible central station manager will see, therefore, that the public eye has long been fastened on the cost of a unit of power and not on the cost of

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a unit of light. This of course is where the public in certain respects dealt with a fallacy. The only ones who did not were the power-users, and they have always represented a lesser force in numbers than the light-users. But the point is, that the light-users could not be very greatly benefited, unless the fixed rates were productive of other advantages found in the way of improved lamps and consequently more light for the same or less money.

This state of affairs has been reached in the last year or so, and in consequence the most conservative of experts will be willing to admit that the race for supremacy of electricity and gas has been won by the former on grounds familiar to both. By the use of low watt lamps, now of increasingly common use on the market, the cost of gas has been so well passed that candle power for candle power electricity is much the cheaper of the two for home consumption.

The Commercial Effect of Bright Lights

The store keeper is, of all engaged in matters pertaining to the merchant's art, an exceedingly wide awake and human individual. One of the indications of his attitude to modern inventions is found in the readiness with which he values new types of light, particularly if they are bright and consequently attractive. The keenness of competition existing between the proprietors of stores is to a large measure responsible for the eagerness with which one seeks to outdo the other in presenting a place of superior brightness and attractiveness. The storekeepers of a large city try every known type of light to accomplish this object without reservation. It would be exceedingly easy to note in New York or other large cities, at least twenty different kinds of light in use including gas as well as electricity within a comparatively small radius.

The truth about the matter is that the storekeeper as well as proprietors of larger establishments, are forced by a competition which has no let-up, to use the best science that the market affords. In other words, bright lights have had an immense effect as a stimulating force in retail commercial circles. No stores on important thoroughfares dare to invite comparison with their neighbors to their own discredit by being dimly or poorly lit. The glare of lights in fact, is one of the characteristics of business streets to such a marked degree, that a newspaper may be easily read in the middle of such a thoroughfare at night. The invention and exploitation of powerful centers of light has been largely instrumental in building up a brisk and healthful competition through which store proprietors actually attempt to outshine each other.

This is not tried in store windows to any marked degree, for it has been decided that here, at least, the light shall be inoffensive and pleasing to the onlooker outside. But for the purpose of calling attention to the store the electric sign has its vogue and either flaming arc or enclosed lamps hold their own.

The central station manager cannot have failed to notice the fact that stores are close together does not in any way diminish the tendency to deluge the place, as it were, in light. Many instances exist, where the demand for public attention is so great, that four or five times the amount of light actually necessary for ordinary purposes is used.

If any observer of such phenomena were to pass just comment on the situation, he would be tempted to refer more to the extraordinary competition in light displays, than to the deeper underlying cause, ineradical in all cases where the most energetic and the most ingenious pass all competitors.

Transformer Design

The danger in the design of a transformer lies not only in the possibilities of defective insulation, but the uselessness of it as an important part of a plant if it fails to regulate effectively. The conditions calling for regulation are such that those at all versed in the requirements of central station practice know only too well the need of a reliable type as well as one which calls for little or no repairs. The idea to be conveyed in these lines, is to the effect that a transformer must meet the demands of the hour without break-down in any particular for a certain number of years at least. One of the most distressing features of old time plants was the expectation of trouble due to insulation, burnt out coils or broken down transformers. Modern practice has not only sought to eliminate such troubles, but seems to have been very successful in accomplishing such ends. The amount of effort and scientific thought concentrated upon this particular type of apparatus before its design eventuated in the form to to-day presents will never be generally known. Difficulties with regulation and insulation have been overcome in conjunction with those presenting themselves as questions of durability and cost. The excellence of the product is such that modern station managers unfamiliar with the old system can never fully realize how changed things are since the transformer has been perfected.

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Over-Voltage in Central Station Work

The rigorous requirements of central station service are perfectly understood by competent superintendents, but in spite of the discipline which prevails lapses are apt to occur injurious to the service, and representing, at times, excesses in voltage. The reverse is also true, namely, that pressure variations may occur in the opposite sense, and the voltage be too low, instead of too high. When the voltage is too low, the objections merely assume the form of a protest against bad light; but when the voltage is too high, that is to say, when the lamps are over candle power, no protest at all is entered, and if anything is said, it is to the effect that "the light is very good tonight." It is evident to the station superintendent, as well as to the reader of literature treating of central station service, that the light may be altogether too good for the economical operation of a plant. In other words, it is essential that any plant which aims at economy must operate along such lines that no waste ensues: otherwise, the investment intended as a source of money-making may absolutely fail.

As far as the variations in pressure are concerned, it is well known that too little pressure or a low voltage does not affect the life of a lamp. But the degree to which an excessive voltage affects the life of a lamp is readily indicated by figures which assume the following dimensions: When the voltage is from one to five per cent higher than normal, the life of the lamp is cut down from its regulation figures to less than one-half. In other words, for each additional per cent. of increased pressure, there is a rapid diminution in the number of hours of usefulness of the lamp. According to records and statistics, the estimate seems to be made on the basis of about three per cent. increase in voltage, reducing the life of the lamp fifty per cent. Below this point, it is hardly necessary to go, for the reason that plants which make a practice of neglecting the correct pressure are few and far between. The experiment of running above pressure is not only costly, but exceedingly troublesome, and for this reason at least station superintendents are very careful to see that no complaint is issued on this basis.

The moral of all this is naturally found in the system of regulation observed: *i. e.*, if the regulation is not limited to voltage variations of less than two per cent., there is danger of a heavy bill for lamps each month. The holding down of the pressure to a practical figure, which also means one representing the greatest economy, is not as easy as it may seem. For instance, in alternating current plants making use of transformers, it is advisable to know in advance the peculiarities of any particular type of transformers employed. If this is not known there is always the possibility of the voltage being a trifle high, or a trifle low, in which case the lighting suffers and complaints are apt to be issued from customers with great regularity. Varying voltage, *i. e.*, a pressure which rises and falls in a sense indiscriminately, is as great a curse to the economics of station practice, as anything that can be imagined. Not only will the customer avenge himself for a form of service which is harassing to him by causing as much annoyance as possible to the lighting company and all concerned, but he suffers individually, in a commercial sense, if in business, or is otherwise troubled if the lighting is at home. Some of the old transformers and older generators are still in use in various parts of the United States, and cause a great deal of trouble along the lines indicated. The station equipment may be in general very perfect, but if the regulation is bad, trouble cannot be avoided, nor can the bill for lamps be cut down.

The station superintendent incurs a responsibility, in taking charge of a plant, which in some respects affects his professional standing. He may find it necessary to raise objections to the use of certain machines, and he may find it very difficult to convince the owners or board of directors that such changes are necessary. If the machinery is bad, he will have to make the best of it, but if the machinery is changed for the better, there is no reason at all why a plant should not operate on this basis in the most satisfactory manner, and make a profit for the stockholders, without very much difficulty. In some instances, plants are subject to misfortune through fires, storms, etc., but, in all towns with a growing population, it is quite natural to expect satisfactory returns from capital invested in electric light plants.

Though occasions arise where superintendents may be lacking in knowledge of what to do and how to operate a plant to gain not only the best results, but a substantial profit, it may be readily realized that the stockholders would, after a fair trial, depose such an individual and get what is commonly called a "hustler" in his place. If a superintendent keeps his eye on the esential things in electric lighting, there is not the least reason why dry rot should enter into the operation of a plant, or why it should fail either as a satisfactory source of lighting, or as a money-maker. Taking it all in

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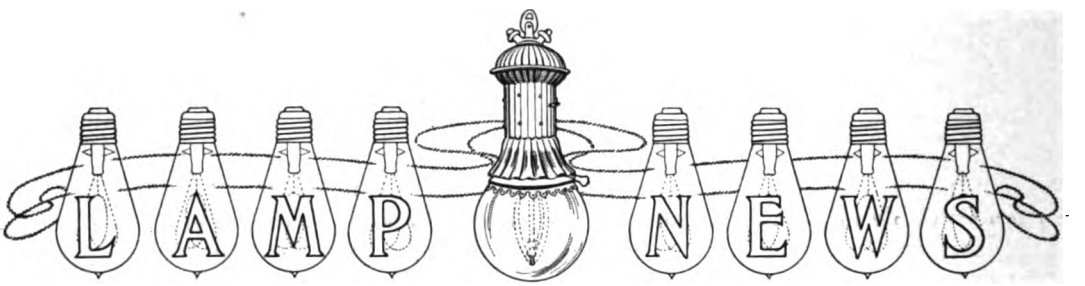
all, the public is pretty easily satisfied. It may not always know what it wants in the beginning, and it may object to that which it receives because it does not seem quite suitable, but when the public is properly supplied, getting what it wants, there is a universal concurrence of opinion, particularly in the case of electric lighting that "the thing is just right." Running central stations successfully is a science as well as an art, and for that reason it is necessary for those intrusted with such responsibilities to study the rules of the game, as it were. That which relates to science or its principles must be carefully studied in order to avoid the pitfalls inevitably presenting themselves in the course of experience. The side which may be called the art of running a central station is more or less the result of a very deep-seated experience which almost amounts to an instinct. Superintendents who have developed the art of running a central station, are exceedingly competent, but with few exceptions they will be quite willing to confess that they kept their eyes on the little things in station practice, while developing the necessary experience required to run the station as a whole.

One department at least of the art of running a central station is that of carefully controlling the pressure. Not only is it necessary to hold the pressure at its proper figure and thereby preserve the plant from criticism, but the result of adhering to a system which preserves the rationale of the plant, is to enforce a form of discipline which in itself is a sure means of attaining success in central station practice than any to which reference could be made.



Aids to the Solution of Practical Illuminating Problems

The science of illuminating enginering is as yet in its infancy, and data of value in the laying out of lighting installations is not plentiful. The activity of the General Electric Company in the advancement of the art of illumination is evidenced by its systematic dissemination of information on this subject. Two bulletins recently compiled by the Harrison, New Jersey works of the company illustrate the thoroughness with which such subjects are now being treated. These bulletins are valuable primarily to the practical man engaged in planning lighting installations and are also of interest to every central station organization as a whole.

A perusal of these bulletins, No. 4561 and 4506 on Gem High Efficiency Incandescent Units and Tantalum incandescent lamps, respectively, will convince the reader of their value as aids to the solution of practical illuminating problems. The illumination tables contained in these bulletins are invaluable in such work and contain information hitherto not available. This data leads itself readily to the laying out of lighting installations and will be appreciated by architects, contractors, solicitors, and others daily confronted with the solving of illuminating problems.

In Bulletin No. 4566 the Tantalum lamp with its high efficiency and long life is specially recommended to central stations as a desirable factor in the reducing of peak load conditions, inasmuch as the use of the 40 or 80 watt Tantalum lamp gives the customer 25% more light than the standard 16 or 32 candle-power lamps, and with an expenditure of 20% less energy on the part of the central station. Thus it is seen that the general satisfaction which attends the use of the Tantalum lamp is shared alike by both buyer and seller of current. Stress is laid on the brilliant and attrac-

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tive quality of light emitted by the Tantalum lamp, qualities which make it most desirable for hotels, theaters, cafés, stores and all public buildings.

The use of the table showing the actual amount saved in dollars and cents by the use of these lamps should prove of great value to lighting solicitors as a convincing argument in favor of the more brilliant and efficient Tantalum lamps This table shows that the Tantalum lamp at the average lighting rates now in force, will save more than twice the initial cost during its average life of 750 hours.

Several pages are devoted to the elucidation of a practical method for the solution of illuminating problems. The illumination table intended for use in connection with this method is comprehensive for the 80-watt lamps with three types of Holophane reflectors, and by interpolation can also be used for the 40-watt and 50-watt Tantalum units. Several curves giving the candle-power distribution with different types of Holophane reflectors are also shown.

Bulletin No. 4561 contains valuable information in regard to "Gem" high efficiency incandescent units. These lighting units are composed of the "Gem" lamps with varying types of Holophane reflectors, and are made in 100. 125, 187 and 250 watt sizes. Candle-power values of these lamps are not given as it is obvious that these values will vary according to the type of reflector used.

The method of solving illuminating problems which was referred to in Bulletin No. 4566, is here treated more fully. The subject of illumination in general is taken up and treated briefly. This is followed by a specific treatment of the subject with reference to "Gem" high efficiency units. Assuming the degree of illumination desired a problem is worked out, reference being made to the illumination tables for the solution.

Two photographs are shown of the interior of a dry goods store before and after the installation of "Gem" units. The original installation consisted of six-light electroliers with ordinary 10-cp. incandescent lamps, placed 7¾ feet from the floor. The "Gem" installation consisted of 125-watt high candle-power units with bowl Holophane reflectors. These units were installed on the ceiling 14 feet above the floor.

Queen & Company (Inc.), of Philadelphia, Pa., one of the oldest and best-known manufacturers of electrical and physical instruments and apparatus in the world, have just gotten out a new arc lamp which they call the Queen Acme Arc Lamp.

This new lamp is the result of careful research and exhaustive experiments in the production of

an arc lamp for maximum iliumination with minimum power consumption. These new lamps, which are shown in the accompanying cuts, are but fifteen inches over all, and the workmanship and design are characteristic of all of Queen & Company's apparatus. This new lamp comprises in compact

form the power and lighting capacity of larger lamps, and has many new and unique features of construction, insuring its perfect operation under all conditions of service. Every lamp is subjected to a long and careful test before leaving their factory.

It is claimed that this new lamp will give a light equal to fifty incandescent lamps with a current

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consumption of but five, and when equipped with an alabaster globe and reflector gives 800 candle-power at 2.5 amperes. With a clear globe and reflector, it gives 1,250 candle-power at 2.75 amperes, while with opal glass it gives 1,000 candle-power at 2.75 amperes.

The above measurements are taken at an angle of 60 degrees, the usual angle for arc lamp tests. It will be seen, therefore, that the new Queen Acme Arc Lamp has a very high efficiency. The light given by this new lamp is of extreme whiteness, closely resembling daylight, which makes it especially adaptable in stores where the matching of the colors of fabrics is important. The shortness of the lamp recommends it especially to low-studded ceilings, and its ornamental appearance recommends it for use in the lobbies of hotels, theaters, and public buildings. One of the noticeable features of this new lamp is the absolute steadiness of the arc, making it most desirable for drafting room work and other places where much close work and observation are necessary. The trimming of the lamp is very simple, and one set of carbons will burn from twenty-eight to thirty hours, making but one trim a week necessary, with an average of five hours a night burning.

The lamps are built for both direct and alternating currents of 110 or 220 volts, and are furnished in any finish that is desired, the standard finishes being black enamel, oxidized copper, nickel-plate and Persian antique, the oxidized copper being the finish usually desired.

G. E. Tantalum Incandescent Lamps

Bulletin No. 4566, just issued by the General Electric Company, Schenectady, N. Y., describes some new types of Tantalum lamps which are now on the market. The lamps are rated for 40, 50 and 80 watts. The 40 and 50 watt types replace the former 44 watt lamp. The 50 watt lamp will enable stations to maintain their output per lamp the same as with the present 16-candle-power lamp, and give the customer 50% increase in the candle-power. An interesting table is given showing the saving secured for 750 hours of service at various loads per kilowatt hour, which indicates that with the average cost of current to the customer now in force, the Tantalum lamp saves more than twice its cost. Under the heading, "Solution of Illuminating Problems," an interesting outline is given of the best methods of selecting proper units for various conditions. An illumination table in foot-candles for various types of reflectors and distances is given, as well as many illustrations of the different lamps fitted with Holophanes and accompanied by candle-power distribution curves. The front page of the bulletin has an illustration of the Meridian Type Tantalum Lamp, which is made in 40 and 80 watt sizes, and provides an ornamental and attractive form of lamp which has materially enhanced its popularity.

Tantalum Lamps

The following interesting data relating to tantalum lamps is culled from the *Bulletin of the Imperial Institute*. The wire used for a 25-cp. lamp measures about 0.05 mm. in diameter, is 65 cm. long and weighs 0.022 gramme, so that one kilogram of tantalum will suffice for 45,000 filaments. The filaments are not arranged in spiral fashion, usual with carbon filaments, but are wound up and down on two series of hooked glass arms. The filaments are stated to be produced by drawing the metal between diamond points.

The "Excello" Celebration

On the occasion of having completed the manufacture of 400,000 arc lamps, the factory of Koerting & Mathieson, Leutzsch, Germany, was honored with a visit by the King of Saxony on February 22nd. A large proportion of these lamps have been the well-known Excello Flaming Arc.

In honor of this occasion, the directors of the works proclaimed the general holiday on Monday, February 24th, when all hands connected with the concern, numbering some 1,400, were entertained by the chief director, Herr Koerting, at a banquet and at the Palm Garden, Leipzig.

Congratulatory letters and telegrams were received and read from every part of the civilized globe.

The Shelby Electric Company, of Shelby, Ohio, has secured the services of Mr. C. A. Davis, formerly connected with the Toledo Railways and Lighting Company, as traveling salesman. The above company is meeting with tremendous success with its new current saving sign lamps, which are now being extensively used by electric lighting stations in the many signs they are installing for their customers.

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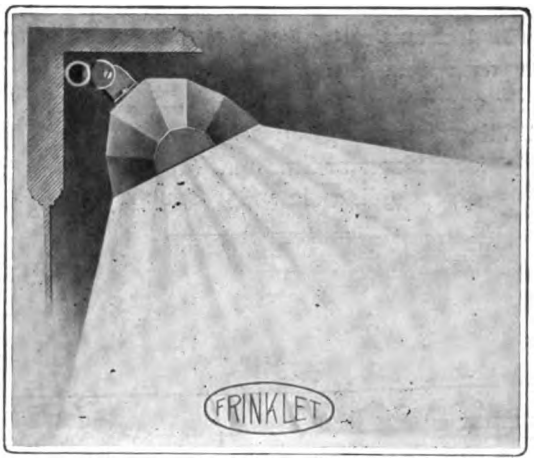
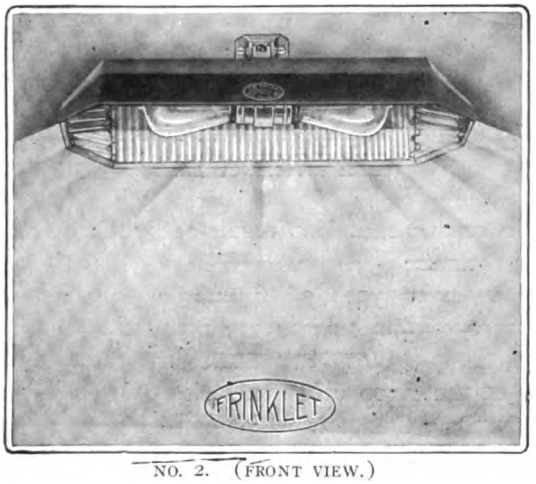
"Frinklets"

I. P. Frink, 551 Pearl street, New York City, the largest manufacturer of hall, church, store and window reflectors in the world, has just gotten out a new line of adjustable reflectors which are known as "Frinklets." Figures one and two show respec-



NO. 1. (END VIEW.)

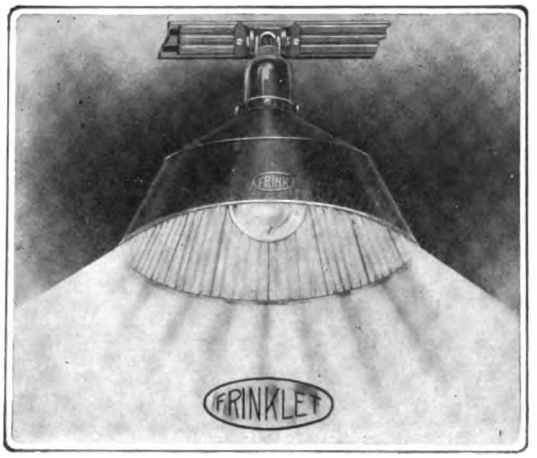
tively the end and front view, show the Twin-light "Frinklet" reflector, and Figure 3 shows the round top "Frinklet" reflector, which is especially adapted for the use of Tungsten, Tantalum and Gem lamps. The twin reflectors, as shown in Figures 1 and 2, are fifteen inches in length, and when used in single or any number of sets required, make an ideal system for the lighting of show windows, all the available light being the goods to be displayed, though



NO. 2. (FRONT VIEW.)

concealing from the eye of the observer the source of illumination. The round reflector, as shown in photograph 3, is twelve inches in diameter, and like the twin-light reflector can be attached directly to molding or conduit, by the special adjustable fittings.

The introduction of these "Frinklets" fills a long-felt want of central station men who are now doing so much construction work for their merchant customers, as it gives them a perfect set of units capable of adapting themselves to any show window conditions, with the advantageous feature of being easily installed and adjusted to any desired angle for reflecting the light rays in the right direction. Both types of reflectors are scientificially designed, giving an evenly diffused light with no shadows. They are made with the usual strong metal frame which characterizes the product of the Frink Company, and are lined with special silver-plated corrugated glass in sections, and fitted with nickel-plated sockets to harmonize with the reflecting surface. One of the best features of all of the Frink reflectors is that any of the glass sections which become broken for any reason can be quickly and easily replaced, as they are all made to a standard



NO. 3. (ROUND PATTERN.)

size. The ability to connect directly to molding, conduit or condulets without exposing any of the wiring, is a feature which will recommend itself to the construction man in every central station.

G. I. Flame Arc lamps are described in a four-page folder being distributed by the General Electric Company, Schenectady, N. Y. This lamp is a simple and efficient American development of the flame arc principle using gravity feed without clock mechanism, and is suitable for any standard make of flame lamp carbons. An illustration of the lamp on the front page shows its handsome appearance. Details of some of the features which are claimed to make this American type of lamp superior to those of European manufacture are given on the inside pages.

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The Adams-Bagnall Electric Company, Cleveland, Ohio, announce a new bulletin, No. 68, descriptive of their direct-current, constant potential, enclosed lamp of the 110-volt type. They will gladly send this bulletin to interested parties.

The valuable table on incandescent lamp data which appeared on page 843 in the "Lamp News" department of the March issue of THE CENTRAL STATION, was prepared by the Engineering Department of the National Electric Lamp Association.

A New Holophane Reflector

The demand for large concentrating reflectors suitable for illuminating high display windows has led the Holophane Company to offer a new reflector illustrated herewith. This is of the "step prism" type, a design in which prisms of the same size are arranged in three rows from neck to base. This arrangement serves to produce an extreme con-

centration of the light rays as will be noted by referring to the following table of the distribution in vertical plane. The lamp employed in this test was a 50-c.p., 125-watt clear gem lamp, reflector No. 9651, being supported in a Form "H" holder.

Degrees.	Candle-power.
0	376.0
10	266.0
20	152.0
30	97.3
40	71.8
50	55.8
60	46.2
70	33.0
80	22.6

Edison "Gem" High Efficiency Incandescent Units

In Bulletin No. 4561 the General Electric Company, Schenectady, N. Y., has issued an interesting sixteen-page pamphlet on illumination and the best solutions of many of the problems involved. The bulletin contains a large number of cuts of the "Gem" lamp and fixtures, especially suited for its installation, etc. Illumination tables giving the foot-candle values of different horizontal planes when the lamp is used with various types of Holophanes are also given. The "Gem" unit is easily renewed, fits the standard socket and burns on any standard circuit. It gives a perfect distribution of light with a downward efficiency of from 1¼ to nearly one watt per candle, and the quality of light is brilliant, soft and uniform, making it especially useful for all interior lighting. The "Gem" units are inexpensive, giving low investment charge and

ONE OF THE 2,200 DIFFERENT STYLES OF DALE FIXTURES FOR HIGH EFFICIENCY LAMPS.

cheap renewals, and no repair account is necessary with their use.

The seven types of fixtures shown on pages 8 and 9 of this bulletin are manufactured by the Dale Company, of New York City, and are but a few of the 2,200 different styles of fixtures made by the Dale Company which can be adapted to the use of these high efficiency lamps. As the General Electric Company does not make these fixtures, it refers its readers in this bulletin to the Dale Company, and the latter company will be glad to furnish any central station with a copy of its catalog showing their large assortment of fixtures and wireless clusters.

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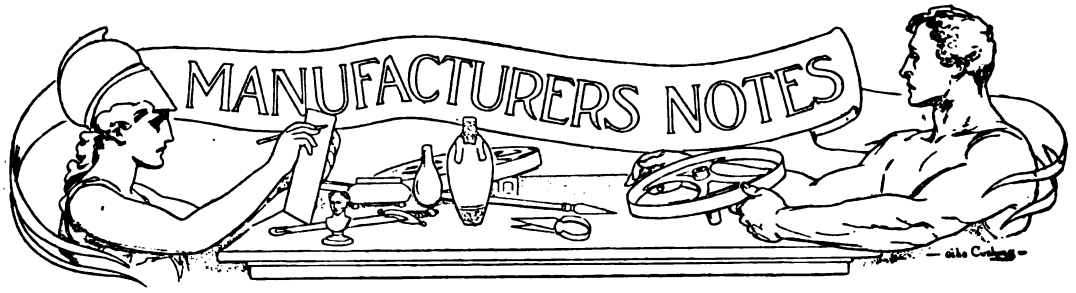
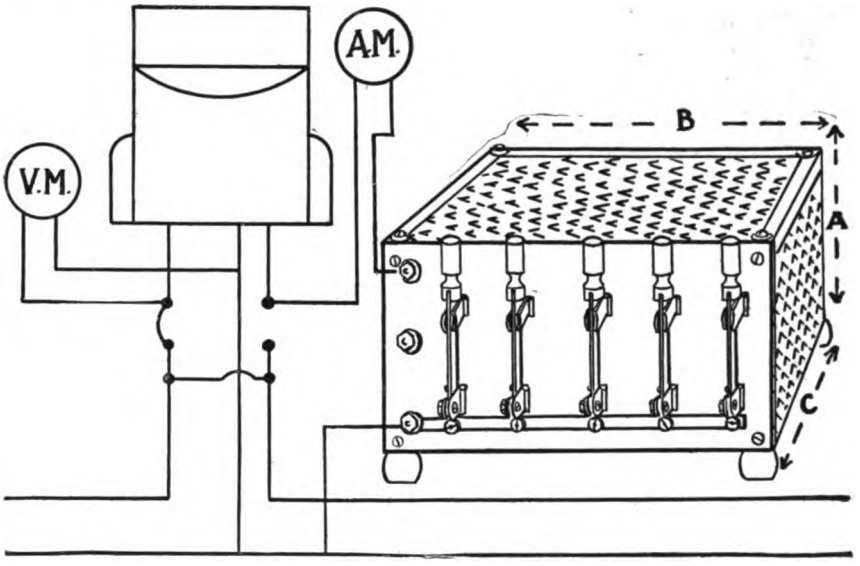


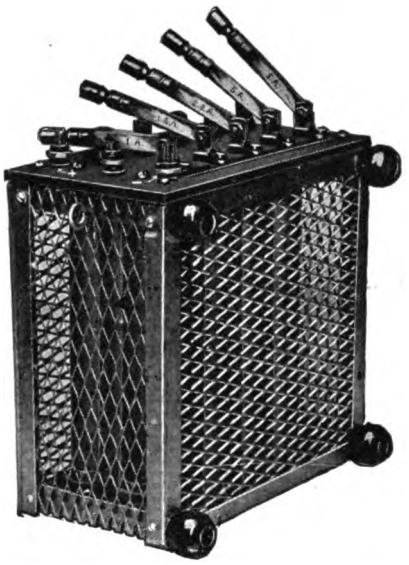
Ward Leonard Electric Company, of Bronxville, N. Y., the well-known manufacturers of rheostats, starting boxes and controllers, are now placing upon the market a new meter testing rheostat, which has jumped into instant favor among many of the leading electric lighting stations throughout the country. This new rheostat has been designed to take the place of the cumbersome and more or less unsatisfactory bank of lamps, and may be used for either direct or alternating currents. The standard catalog types are designed for 110 and 120 volt circuits, and are suitable for testing meters of 150 amperes capacity or less at 1/10 loads. These rheostats are light in weight, they are mechanically strong, and are readily carried by the meter testing man, they being enclosed in a case complete in itself. The resistance elements are mounted upon the face-plate, and the rheostat can be taken apart by removing four small screws. The resistance element is built up of standard enameled resistance units, which are always carried in stock. Each element is connected across the full line volts, and will carry the full amperes which can be made to pass through it by the impressed voltage. The various ampere steps or combinations are secured by paralleling the resistances. If, through error, the resistances are connected across 240 volts, they will not burn out before the tester has discovered his mistake and rectified it. Each resistance element is composed of a porcelain tube wound with a special resistance wire of practically 0 temperature co-efficient. The tube, after being wound with wire, is covered with a vitreous enamel which holds the wire firmly in place. Grounding is absolutely impossible as the support is composed of a perfect insulating material. The coating of enamel makes the entire surface of the tube available for emitting heat energy instead of merely the small surface of the wire, thus greatly increasing the watt capacity of a tube of given size. The finest wire, when properly imbedded in the special enamel used for these resistance units, is entirely free from any mechanical strain due to the heating and cooling, and is perfectly protected against all oxidation or other chemical depreciation.



TYPICAL CONNECTION DIAGRAM.

The Ward Leonard resistance units have been

employed by thousands of users and millions of these resistance units are in successful use continually all over the world. The enclosing case of these rheostats is finished in aluminum, and this type of meter rheostat can be made for any voltage and in any capacity. If central station men will state their requirements, the Ward Leonard Company will gladly give them the proper information as to



the style of meter testing rheostats suitable to their needs, at the same time quoting them prices, as well as the weights and over-all dimensions.

Aside from the economy, ease of transportation and the ability to test quickly and accurately a customer's meter, central stations have received no complaints from customers from what they consider an unnecessary waste of light, which they are paying for when they see the tester at work using a bank of fifteen 32-candle-power lamps for the burning of which, during the test, the owner has to pay in extra current. It has frequently happened, after the old method of testing, that the disgruntled customer has gone to the central station with the complaint that the current used in the testing of his meter, and the fact that fifteen 32 candle-power lamps have been in circuit for a considerable length of time during the test amounted to more current than he would have used for his ordinary house lighting in a week.

A Universal Family Sewing Machine Motor

All sewing machines may look alike, but the fact that they are not alike is brought home very frequently to the central station man when it comes to supply the demand for sewing machine motors.

This application of the motor is so highly appreciated in the household and there are so many sewing machines of various makes in use that the demand for sewing machine motors, though already extensive, is just beginning to make itself felt. It offers a decidedly attractive means of increasing the business of the central station.

As the demand increases, the central station man or dealer finds himself in need of a motor that can be attached to one make of machine as well as to another. Otherwise a nice and profitable business is bound to become troublesome to handle and require the carrying of a large stock of motors and consequently a considerable investment.

To meet the demand for a motor that will reduce the selling effort upon the part of the dealer to the minimum and enable him to get prompt returns, the Westinghouse Electric & Manufacturing Company has placed upon the market a motor with all the necessary attachments for fitting any one of the standard types of sewing machines.

This motor is equally satisfactory on drop head and stationary head machines, and may be fitted to new or old machines. Full instructions for mounting and operating the motor are supplied with each outfit.

The motor is mounted on the top of the table and runs at a constant speed. The speed of the needle is regulated by increasing or decreasing the belt tension. A special brake and belt tightener arm is attached by chain to the foot pedal, which should be disconnected from the large balance wheel. Pressure on the pedal releases the brake, tightens the

belt and starts the machine. Perfect regulation of the speed is obtained after a few minutes' practice. In fact, the needle may be stopped with greater promptness than when running from the foot pedal,

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and the usual control over the speed is readily learned.

The entire outfit presents a neat appearance, being well finished in black japan with nickel trimmings.

The motor and its attachments are especially well made and will require a minimum of care and of attention in operation.

These machines are made for 100-110 volt alternating current, 60 cycles, and for 100-110 direct current circuits.

The Westinghouse Electric and Manufacturing Company has recently completed the installation of a large number of motors for the San Rafael Paper Manufacturing Company, of Mexico. These motors vary in capacity from 10 to 150 hp. They will be used in the operation of several machines and tools in the factory of the San Rafael Company, which is located about 36 miles from the City of Mexico. The company obtains its electric current for driving the motors from the Mexico Light & Power Company, at a potential of 20,000 volts. Six 120-kilowatt oil insulated transformers reduce this current to a working pressure of 440 volts. A switchboard to control the various transformers and motor circuits is furnished with the contract as well as a number of individual switchboard panels located near each other. This installation is considered the most modern and economical plant of its kind in the Republic of Mexico.

Following the lead of progressive central stations all over the country toward the use of modern steam turbine as the type of prime mover best adapted for electric lighting and power purposes, the Memphis Consolidated Gas & Electric Company, of Memphis, Tenn., during the latter part of November, 1906, placed in service a 1,500 kw. Allis-Chalmers Turbo Generator Unit, together with complete condensing and auxiliary apparatus. This unit, which follows the standard Allis-Chalmers design for 60 cycle, 2,500 volts, 3 phase, has been in continuous operation since that time, running from 14 to 18 hours per day, excepting Sundays, with a load ranging from 1,200 to 2,000 kw. During this period there has been no shut down whatever, attributable to the prime mover.

For lighting and power plants in small towns, factories, office buildings, public and private institutions, etc., there is a steady demand for alternators of moderate capacity. Allis-Chalmers Company's "AB" alternators of the new "self-contained" type, are especially suited for requirements of this kind where a belted generator not exceeding 150 kw. output is needed, and, although put on the market only recently, they have already been installed in every section of the country.

These machines differ from Allis-Chalmers Company's well-known "AH" generators principally in the fact that they require no bed-plate, the two bearings being carried in end housings bolted to the stator yoke, the feet of which rest directly on slide rails. They are, therefore, somewhat lighter and take up less room than the older machine, which is always provided with a base and pedestal bearings, "AB" alternators are now purchased, as a rule, for the smaller capacities; while the "AH" machines may be had in any size for which a belted unit is adapted, up to 800 kw. or more.

F. A. Lawson & Company, 209 Monadnock Building, San Francisco, Cal., have secured the Pacific Coast agency for Dossert & Company's solderless cable connectors and terminals and have already placed large orders for Dossert joints. F. A. Lawson & Company report great activity in the electrical construction field on the coast.

D. Van Nostrand Company, publishers of scientific books, of 23 Murray street, New York City, are meeting with ever increasing sales for the new Fifth Edition of Foster's "Electrical Engineer's Pocket Book." This new edition is handsomely bound in flexible leather of convenient size for the pocket, and the useful tables and data, together with illustrations and diagrams, makes this a real engineer's library in itself consisting of 1,100 pages. Among the important subjects treated in this book are the following:

Symbols, units, instruments, measurements, magnetic properties of iron, electro-magnets, properties of conductors, dimensions of conductors for distribution systems, underground conduit construction, cable testing, dynamos and motors, tests of dynamos and motors, the static transformer, standardization rules, electric lighting, electric street railways, electrolysis, transmission of power, storage batteries, switchboards, lightning arresters, electricity meters, wireless telegraphy, telegraphy, telephony, electricity in the U. S. Army, electricity in the U. S. Navy, resonance, electric automobiles, electro-chemistry and electro-metallurgy, rays, electric heating, cooking and welding, lightning conductors, mechanical section. The book will be sent to any address upon receipt of five dollars.

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The Helios Manufacturing Co., of Bridesburg, Philadelphia, Pa., manufacturers of the Helios Flaming Arc Lamps for all currents and circuits, and who are also manufacturers of the well-known storage batteries of the same name, have just placed upon the market a new and improved type of storage ignition battery, which is meeting with marked success.

The containing case is of very heavy hard rubber, divided by hard rubber partitions into two or three compartments so as to contain either two or

three separate elements. The compartments are each provided with a cover which is sealed into place, and over these individual covers is placed a heavy hard rubber master cover, which effectually conceals all of the live parts, and entirely prevents the slopping of acid even under severe service.

On the bottom of the containing jars are strips of soft rubber, and a soft rubber band passes entirely around the lower portion of the case so that shocks from severe road service are absorbed sufficiently to prevent the jars from being broken.

The handle by which the complete battery can be carried is of rubber webbing, and there is absolutely no metal exposed to become corroded, nor is there any wooden case to become saturated with acid, thereby not only destroying its appearance, but causing a leakage of the current from one cell to another.

The binding posts consist of 5/8" round antimonious lead posts threaded at the top, through the side, of which at the bottom of the thread is drilled a hole to receive the conducting wire. The post is also drilled from the top vertically, the vertical and horizontal holes meeting, and in the vertical hole a tongue is inserted, the tongue being attached to a hard rubber cap, which by screwing down on the post securely holds the conducting wire in place, and at the same time covers up the post so that absolutely no metal is exposed with which accidental contact might be made.

It will be noted that there is no brass used at any point in this battery, nor is there anything which can be deteriorated or acted upon either by acid or fumes. The elements are of the standard Helios type, which have been favorably known for many years, and which have given the most excellent satisfaction owing to their long life and high weight efficiency.

The construction of this battery is so simple that in case of damage or deterioration of the elements, the same can be replaced by a novice, and all the parts are interchangeable so that repairs can be furnished at any time if needed. The simplicity of the battery, the beauty of the design, the absence of all metal or wooden parts which can be injured by the acid or fumes, makes this battery superior to anything on the market at the present time, and being manufactured in large quantities, are sold at prices which have heretofore been considered impossible.

The American Steam Gage and Valve Mfg. Co., of Boston, Mass., the largest manufacturing concern of its kind in the world, has just issued a most complete catalog consisting of 246 pages and bound in red cloth, illustrating and describing, with price lists, their complete line of gages, indicators and valves for every service. The book in itself is an education on this important subject to electric lighting and power stations.

American Transformer Company, of Newark, N. J., have recently secured the services of Mr. A. Press, formerly conected with the Siemens and Halske Company, who will be the chief electrical engineer.

The Dossert Solderless Connector Company. The annual report of Dossert & Company for 1907 showed an increase in gross business of 27½% notwithstanding a falling off in the last quarter

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owing to the slowing down of construction work. There has been a marked increase of orders, however, since the first of the year, the figures for January showing a large increase over the same month last year.

The New York offices of Underwriters' Laboratories, Inc., have ben moved from 29 West 39th street, to 12th floor of the building 135 William street, where the offices of the National Board of Fire Underwriters are also located. Mr. George E. Bruen, employed in an engineering capacity by the National Board, will take up the laboratory work in connection with his other duties, and has been appointed engineer for Underwriters' Laboratories, Inc., to have charge of the business of that corporation in and around New York City.

Mr. J. B. Cowen, who for eight years was prominently identified with the General Incandescent Arc Light Company, of New York, and later with two large manufacturers of storage batteries, has recently resigned from his last position which kept him away from New York City, which is his home, and is at present taking a much needed rest. Mr. Cowen is not only a practical electrical engineer, but has had a great deal of experience in the selling departments of the various companies with which he was connected.

He is an accomplished linguist, speaking fluently French, German and Spanish; and having had a wide experience in newspaper and magazine work, would make a most valuable man in connection with the publicity or export departments of any large electrical manufacturing concern.

THE CENTRAL STATION cannot recommend too highly Mr. Cowen's services, and any communications directed to him, in care of THE CENTRAL STATION, will be forwarded to his address.

The lighting transformers described in Allis-Chalmers Company's bulletin No. 1061, are of recent design and include all the features that have proved most advantageous for lighting work. Every detail of their construction has been most carefully worked out by designers of wide experience with this class of apparatus. Special care has been taken to secure thorough and permanent insulation between primary and secondary coils, as well as between the coils and core.

It has been the endeavor of that company to eliminate core loss, which is a constant drain on the coal pile. The obviating of this constant loss has been brought about by the use of the best quality of iron obtainable, annealed and varnished on both sides with a special varnish unaffected by the oil in which the transformer is immersed. The above bulletin not only contains a minute description of the transformers, that have established a notable record in economy, but information on insulating oil and insulation tests can be secured by consulting this publication, a copy of which may be had upon application.

The Durability of Modern Electrical Apparatus

Electrical apparatus, when constructed in accordance with the best engineering practice, is well nigh indestructible if subjected only to the ordinary amount of wear and tear, and often comes out with flying colors from the devastating reign of floods and fires. The few incidents quoted below are excellent examples of the amount of hard usage that well constructed electrical apparatus will survive, and still be in working condition.

In the Knights Deep Mine near Johannesburg, South Africa, there were installed thirty-six 15-kw. transformers and twelve three-phase, 50-hp. General Electric induction motors for operating the mine pumps. Through a peculiar combination of circumstances, the mine was allowed to fill with water—the motors and transformers remaining under several hundred feet of water for over two years.

When taken out, three of the motors were rewound in the local repair shop. The others were simply dried out and then soaked in oil. Contrary to all expectations and to the surprise of all concerned, the insulation was found to be in excellent condition, and the motors were put into service—apparently none the worse for their high pressure bath. The transformers were treated in the same manner, and shortly afterward they replaced several transformers of English make which had burned out only a short time after being installed.

A railway power station situated near the Mississippi River experienced a severe flood during the season of high water. Two 1,500-kw., 6,000-volt generators were more than half under water for nearly a week, but when dried out carried their load without giving any trouble whatever. In fact, the first machine to be dried out, carried the entire railway load until the second machine could be put into condition.

A three horse-power induction motor was taken from the ruins of the printing office of *The Democrat*, Ellsworth, Maine, some few days after the en-

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tire building had been destroyed by fire. After being freed from the protecting coat of ice and cinders, the motor was dried and cleaned. When connected to the circuit it ran as smoothly as when first installed. Some idea of the intensity of the heat to which the motor was subjected may be gained from the fact that the switchboard and instruments were completely destroyed.

A General Electric 20-horse-power, 550-volt, three-phase induction motor, installed in a leather warehouse in Salem, Mass,. was subjected to a severe ordeal during a fire. After the building and its contents had been deluged with water, the motor was removed, and after being cleaned, dried and fitted with another pulley, started immediately on application of the current. The motor has since carried its rated load, and does not appear to be damaged in any way except as to appearance.

Another excellent example of the durability of the induction motor was shown by the remarkable performance of a General Electric 5-horse-power motor which was used in driving a pump in the G. H. Perry Co.'s quarry in South Dakota. The motor was often allowed to run without any attention over night, especially during the rain season. One night a heavy rainstorm filled the quarry to such a height that the motor was half under water. When started the next morning, it picked up its load and carried it steadily until the pit was emptied of water. On examination it was found to be none the worse for its prolonged bath, although a new pulley had to be put on in place of the old one, which was softened and warped out of shape.

New Allis-Chalmers Alternator for Nevada California Power Company, Goldfield, Nev.

The Nevada-California Power Company, formerly the Nevada Power, Mining and Milling Company, Goldfield, Nev., is preparing to install a fourth Allis-Chalmers alternating current generator, of the water-wheel type, having 1500 kw. rated capacity, to augment the enlarged power service, now contracted for in the vicinity, pending the completion of their new hydro-electric station on Bishop Creek, Inyo County, California.

The unit is a 3 phase, 60 cycle, 2200 volt machine to run at 400 R. P. M., and is arranged for direct connection to a water-wheel operating under an 850 ft. head, alongside of three similar units already installed and similarly driven, the last of which was placed in service in 1905.

These generators are of the standard Allis-Chalmers water-wheel type, with two bearings and extended shaft. The stationary armatures of the machines are of the usual construction, with box frame self-supporting yoke. The rotor spider is specially strong in order to stand abnormal water-wheel speed in case the governor should fail to work. The spider is a solid steel casting and the pole pieces are securely held by dovetail projections. The field windings are of copper strip wound on edge and designd for 120-volt excitation.

Current from these generators is transmitted 113 miles at 60,000 volts to Tonopah and Goldfield, Nevada, with branches from this line to other points, and supplies power to a number of the mines in that district whose equipment is electrically operated. The following are a few of the properties in Tonopah and Goldfield which have installed Allis-Chalmers Induction Motors ranging in size from 5 to 100 h.p., and are supplied from the Nevada-California Power Company's mains.

Goldfield Consolidated Mines Company, Goldfield Milling and Mfg. Company, Nevada, Goldfield and Reduction Company, and Montana Tonopah Mining Company. The latter company has installed fifteen motors aggregating 600 h.p.

With the completion of its two stations, the Nevada-California Power Company will possess hydro-electric power facilities unequaled in this section, as there are two plants already in operation and the combined capacity will be 14,000 h.p. Much additonal power can also be developed, as the company controls 3,200 ft. of fall on Bishop Creek, and large storage reservoirs can be built on the headwaters of the stream at no great cost.

The contract for the electric turret-turning gear of the U. S. S. *Delaware,* now under construction at Newport News, has been awarded to the Cutler-Hammer Mfg. Co., of Milwaukee.

This company designed and built the electric turret-turning gear installed in the port, after turret of the *Indiana,* the crew of which holds the world's record for markmanship—ten shots in two-and-a-half minutes, all hits.

Every modern war vessel is equipped with a complete electrical plant, the specifications of some of the newer battleships calling for generators having a combined output of 800 kilowatts.

In addition to illumination, wireless telegraphy and interior signal systems electricity is used on shipboard in connection with the refrigerating plant, ventilating fans, forced-draft blowers, and for operating ammunition hoists, boat cranes, deck winches, etc.

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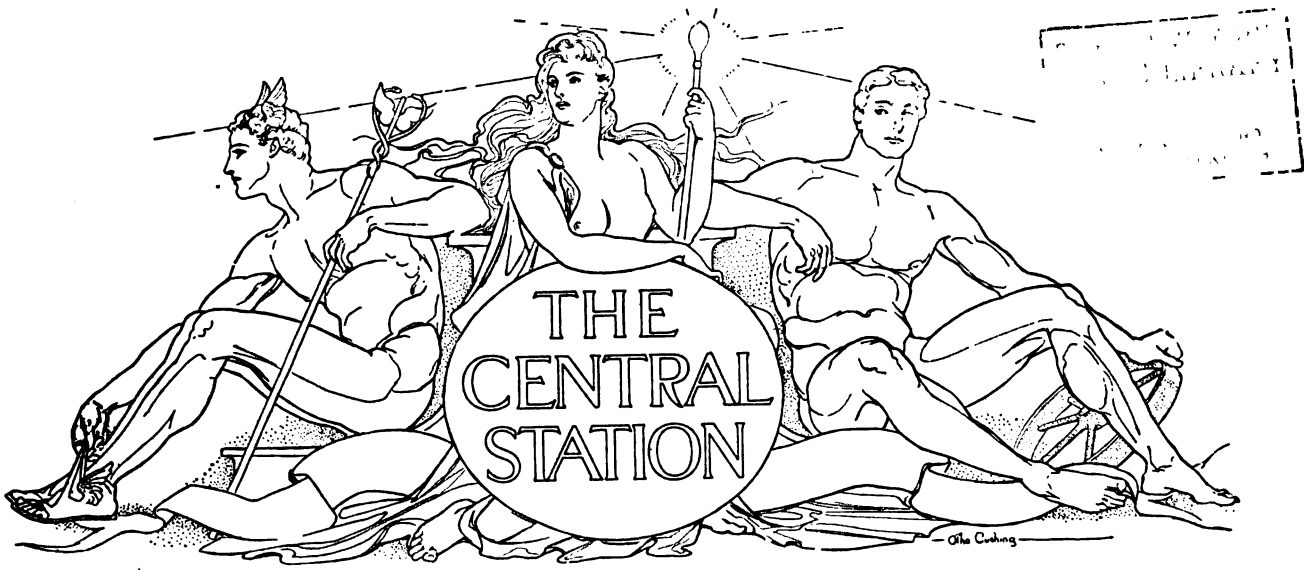

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, NO. 11. NEW YORK, MAY, 1908. ISSUED MONTHLY.

Instruction in Mechanical and Electrical Engineering at Cornell University

BY PROFESSOR HENRY H. NORRIS.

Cornell University is made up of a number of distinct colleges, independent in the management of their own affairs but represented on a general university faculty which controls in matters of a general nature. For example the setting of entrance and graduation requirements, while the determination of the university calendar, the supervision of athletics, student discipline and such general duties fall to the University faculty. The colleges into which the University is at present divided are: The College of Arts and Sciences; The Sibley College of Mechanical Engineering and the Mechanics' Arts; The College of Civil Engineering, The College of Architecture, the Medical College (partly located in New York City), the College of Law, The New York State College of Agriculture, and the New York State Veterinary College. The last two are supported by the State, but their affairs are managed through the regular university organization. Sibley College has now about twelve hundred students, more than one-third of the total number of regular students. The proportion of students in all branches of engineering is nearly one-half.

In the issue of this paper for May, 1904, Prof. Harris J. Ryan, who was at that time head of the Electrical Engineering Department in Sibley College wrote very fully on the development of the institution, and stated accurately and concisely its purpose. He gave in detail the curriculum of studies and described the material equipment. In the four years which have elapsed since this article appeared, a number of important changes have been made, and the college has grown in all directions. The organization at present comprises the departments of (a) Machine Design and Construction, (b) Experimental Engineering, (c) Power Engineering, (d) Electrical Engineering, (e) Naval Architecture, (f) Marine Engineering and (g) Railway Mechanical Engineering. All courses are substantially alike for the first three years, and the amount of specialization permitted in the fourth year is not sufficient to differentiate the students to any considerable degree. The purpose of all the training is to lay a theoretical and scientific foundation for future work, and to illustrate by means of special courses the method of application of the fundamental laws to various forms of engineering. All students are graduated with the degree of mechanical engineer, with reference to the particular courses which they may have been taking while in college.

The course in Sibley College may be best understood by following the various studies taken during the four years. In general, it may be noted that the

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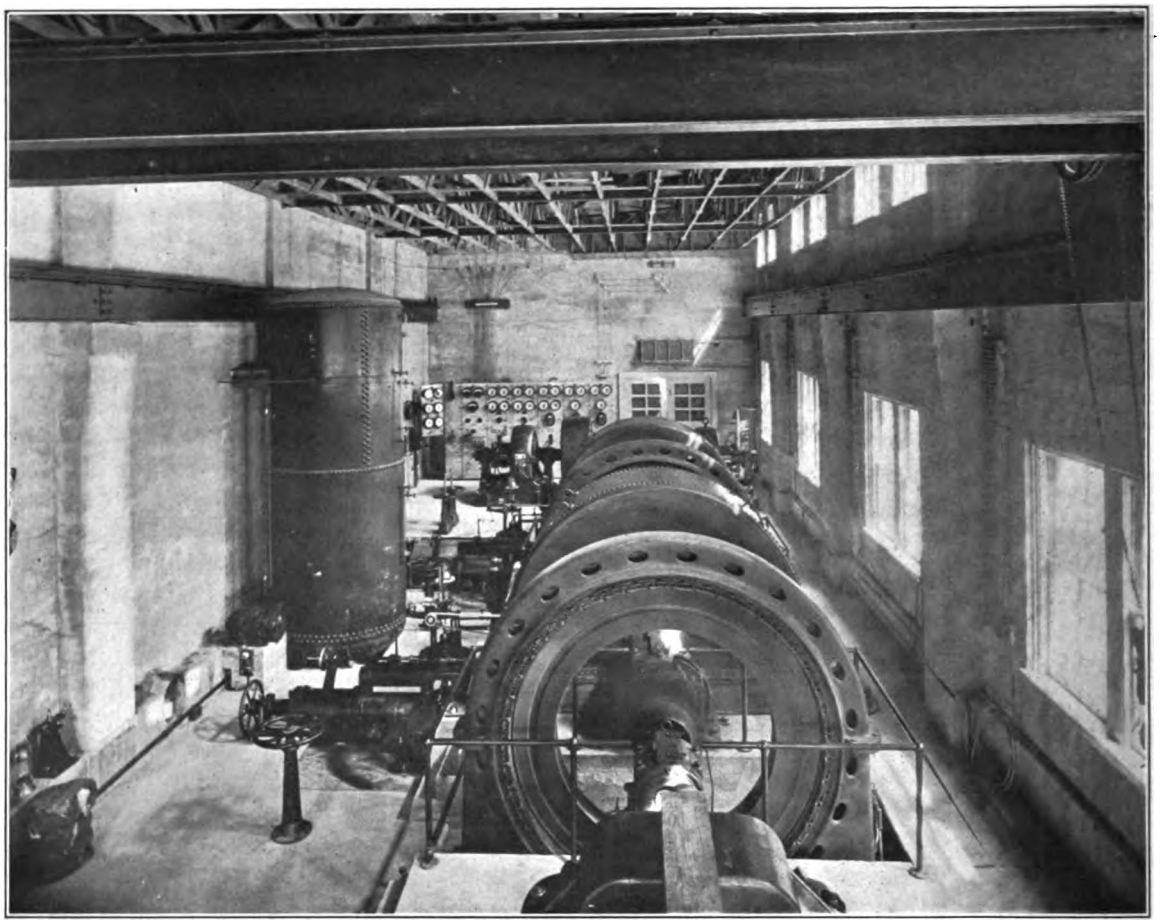
first year is occupied largely in scientific preparation for the remainder of the course. Analytic geometry, and differential and integral calculus, accompanied by a short course in descriptive geometry, furnish the mathematical basis for engineering work, and these occupy approximately one-third of the freshman year. Courses in elementary physics and chemistry initiate the student into the important facts and laws of pure science. Elementary mechanical drawing, including machine sketching, let-



INTERIOR OF CORNELL UNIVERSITY POWER PLANT.

tering and the use of instruments, give him practice in putting his ideas into tangible form. Practice in pattern making is also introduced, and it is accompanied by lectures on engineering principles, in which the nature and objects of engineering instruction pointed out to the students. This object is not that they shall become skilful in handling tools, but rather that they may learn the theory underlying all successful manufacturing and operating processes. Pattern making is studied and practised so that the student will understand what kinds of pieces may be molded, and how they should be molded. The student learns whether the pieces are to be machine molded or hand molded, whether sand or iron molds are desirable, how the molds should be parted, how the cores should be made and inserted and matters of this nature. In addition to the college work proper the freshman also has military drill under the direction of a United States Army officer, detailed for service at the University. In the second year mathematical processes are applied in a course in the mechanics of engineering, which is considered by the faculty one of the most important in the entire series. The sophomore continues his studies in physics and chemistry, and takes up more advanced work in drawing and elementary machine design. A course in kinematics shows him the laws involved in the motion of the various parts of a machine, while a course in materials of engineering furnishes a general knowledge of the raw

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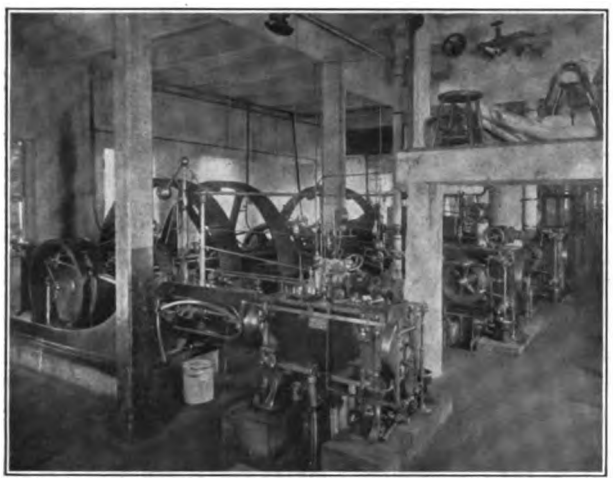
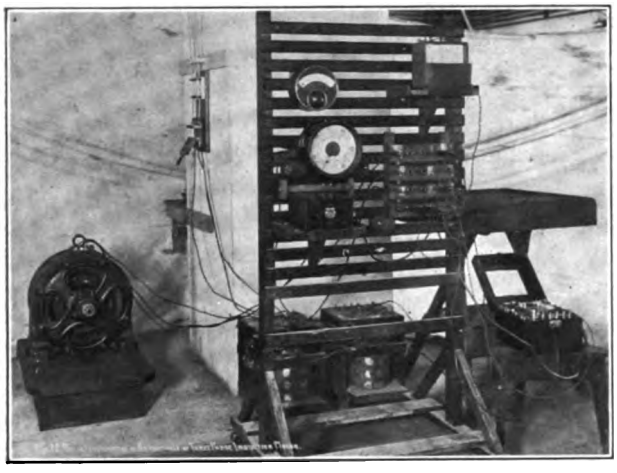
materials from which machines are constructed. Foundry work naturally follows pattern making, and this is accompanied by a course in forge work.



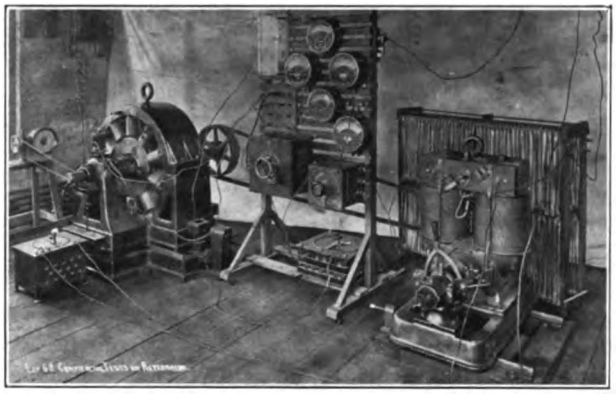
EXPERIMENTAL TRIPLE EXPANSION ENGINE.

The first two years, having laid a good scientific foundation for engineering work, are followed by the junior year, in which the studies are of an engineering nature. The student becomes familiar with thermodynamics and the principles of steam machinery, both by theoretical study in lectures and



MOTOR TESTING.

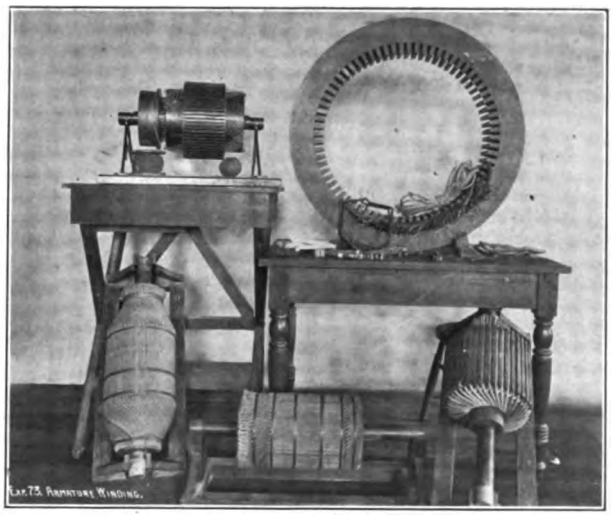
recitations and by experiments in the mechanical laboratory. At the same time he takes up the principles underlying electrical engineering, and learns the nature of the various fields of electrical application. The study of electrical principles is also accompanied by experimental study in the electrical engineering laboratory. In the junior year machine design is taken up in an advanced manner by lectures, recitations and drafting. In this course machine tools are designed in such a way as to show the application of the fundamentals learned in the earlier years. The machine shop illustrates these applications in a practical way. The accompanying lectures on the principles of manufacturing show how machine tools are applied in producing pieces both in large and small quantities. A course in hydraulics, recently introduced, gives some insight into the flow of water in pipes and open channels and the production of mechanical power in hydrau-



ALTERNATOR TESTING.

lic motors. From these statements it is evident that the junior year is devoted to preparation for engineering studies, containing as it does, those courses which serve to connect scientific principles with their industrial application.

In the senior year the student in Sibley College



EXERCISE IN ARMATURE WINDING.

is required to follow certain general studies, but outside of this a great deal of freedom in selection is allowed. The fundamental studies are (1) Power

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plant design, (2) elementary economics, (3) mechanical laboratory and (4) electrical laboratory. In power plant design the object is to suggest those broad general principles underlying the efficient assembling of various units into a complete station. The relation of all the elements of such stations are discussed, and the student's judgment is cultivated to enable him to select or reject apparatus intelligently. The course in economics gives him hints as to the problems involved in transportation, hiring of labor, finance, and such subjects with which he is sure to have a great deal to do in his future life.

The student in his senior year specializes to some extent, although none of the specialties are offered him with the view of preparing him for particular fields of usefulness. The senior may take up steam engine design, the design of machine tools, electrical engineering, naval architecture, marine engineering or railway mechanical engineering. Any one of these courses will occupy two-thirds of the time during the senior year.

Instruction in electrical engineering is given to all students in order to show them what can be done with the electric current, and in a general way to familiarize them with ordinary electrical apparatus. For those who desire to specialize in the senior year more advanced instruction is provided. The subject is approached from three points of view: (a) experimental, (b) analytical and (c) graphical. Each senior follows through a series of problems, in which he is given the dimensions of various electric circuits and machines. From these, by the application of elementary principles, he predicts the performance of the machines under all conditions of operation. For example, when given the length of a transmission line, the distance between wires, the sizes of wires and their arrangement, he predicts the regulation of the line with load of various power factors. Similar problems are worked through for transformers, induction motors, alternators, etc. In the laboratory a large variety of experiments show the characteristics of the machines under operating conditions. They also familiarize the students with the appearance and construction of various types of apparatus.

During the second term of the senior year a number of courses are offered by specialists in the different departments of the electrical field, these courses being planned simply as illustrating the manner in which the several industrial requirements are met. Electric railway engineering, telephone engineering, power generation and transmission, and the design of electrical machinery are the topics treated this year. The students do not become engineers or designers in these various fields, but they learn enough of each to appreciate the kind of problems which predominates. In addition to these courses the electrical enginering students select work in other departments, and an attractive variety of elective courses is offered. Each specialist in the college is willing to show the students the elements of his specialty. The following will indicate some of the most popular of these general courses; pumping machinery, hydraulic power plants, motor car construction, internal combustion engines, heating and ventilating, resistance and propulsion of ships, motor boat design, refrigerating machinery, steam boiler design, steam turbines, gas manufacture and distribution, railway machinery, etc. Formerly each senior in the college was expected to prepare a thesis comprising some kind of original investigation. A few years ago this compulsory thesis was abolished, and the students were allowed to elect an equivalent number of hours. As a result the number of theses has been very much decreased, but those who do original investigation take this up because they prefer it and not because it is required. It is thus expected that while the given quantity of research work has been reduced, the quality will be greatly improved.

Reviewing the Sibley College course as a whole, it will be noted that at first several apparently disconnected studies occupy the student's attention, but as he advances in the course these studies are more and more coördinated. When four years have elapsed, coördination is complete, and each student has learned how his studies are applied in some particular field. It is quite possible that he will not work in this field after he has graduated, but before leaving college he has seen at least one application of mathematics, physics, chemistry, drawing and shop work. He is then ready to begin again in practical life, taking at first a position of minor responsibility in order that he may learn the business principles upon which successful engineering must be based.

In this study of Sibley College and its curriculum, emphasis should be laid upon the fact that buildings and studies are but a part of the entire educational plant. There are four elements of success in technical education, namely, teachers who can teach, students who can learn, equipment which can be used efficiently, and a curriculum of studies which will economize the student's time, but will at the same time force him to such mental exercise that he will become a clear thinker. Sibley College

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has always been fortunate in its faculty and its students, and the management is constantly endeavoring to improve the equipment and the curriculum with the above objects in view. The members of the faculty are selected from those who have practical experience combined with theoretical training, and who teach because they prefer that to doing anything else. While primarily teachers, they are at the same time engineers in the broad sense. In some cases they are well known as engineers entirely aside from their teaching work. The students are a hearty and enthusiastic set of young men who come to college to work. The rather severe entrance requirements and the strenuous program laid down for the four years bar out incompetent and lazy students. A spirit of good fellowship prevails, and faculty and students meet on a common level. Abuses and misunderstanding when such arise are speedily adjusted by conferences between faculty and students, and the routine work moves along with little friction.

The students have interests outside the class room which tend to bind them together more firmly, and to increase their pleasure in the courses. Athletic contests with other colleges of the university, are a source of no small enjoyment. The Sibley Engineering Club, meeting once or twice a month, brings students and faculty together on a friendly footing, and stmulates the more formal parts of the work. The local section of the American Institute of Electrical Engineers is very strong, and supplies that contact with the electrical problems of the day that is needed to spur the students to their best efforts.

In conclusion the writer wishes to express appreciation of the opportunities presented for technical graduates in central station work. Sibley College does not, and will not as long as the present purpose remains, endeavor to fit young men directly for central station or other specific lines of work. A broad general training is the kind that will bring the best results. The field of central station work is one which is demanding the best general preparation on the part of those who aspire to enter it. This field has not heretofore been as attractive as some, largely because there has been no systematic way by which admission could be gained to it. Manufacturers have provided apprentice courses to adapt the school training to their business, and technically trained young men have been secured for

GRADUATING CLASS IN ELECTRICAL AND MECHANICAL ENGINEERING, CORNELL UNIVERSITY, 1908.

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this work in large numbers. It is highly desirable that something of the same sort be undertaken by the managers of power stations and other properties which must be operated efficiently. Some years ago the Denver Gas and Electric Company inaugurated a movement of this kind, and at present the electric railway companies are manifesting interest in a somewhat simliar scheme. The writer laid before the American Street and Interurban Railway Association at its Atlantic City Convention of last year a tentative division of eighteen months of an apprentice's time, by which the theoretical training may be made effective in electric railway work. As it is necessary for a student while in the technical school to devote himself almost entirely to the theoretical basis of engineering, he must in order to learn the details of any particular profession, spend some years in contact with actual work after graduation before he "finds himself" and becomes a real engineer.

Some Results of Steam Heating from a Central Station

By James A. White.

The distribution of steam through underground mains for supplying heat to the business and residence districts of towns and cities, where weather conditions are severe enough to warrant the investment, is becoming more widely known every year. While this method of heat distribution has been in continuous and successful operation for thirty-one years, yet there is still a surprising lack of knowledge and appreciation on the part of many engineers and central station operators as well as the general public, in regard to the many economies and benefits secured from this system of heat distribution. Among the many advantages to the consumer is the convenience of having heat available in any quantity at any time of day or night without the care and dirt which is the accompaniment of the usual furnace, perfect service with greater economy, reduced fire risk, and a gain in storage space formerly required for coal and ashes. Buildings so heated are much more easily rented and can command considerably higher rents other things being equal. That these advantages are soon learned by the public is evidenced in the rapid growth of the heating business in the towns and cities where such plants have been installed.

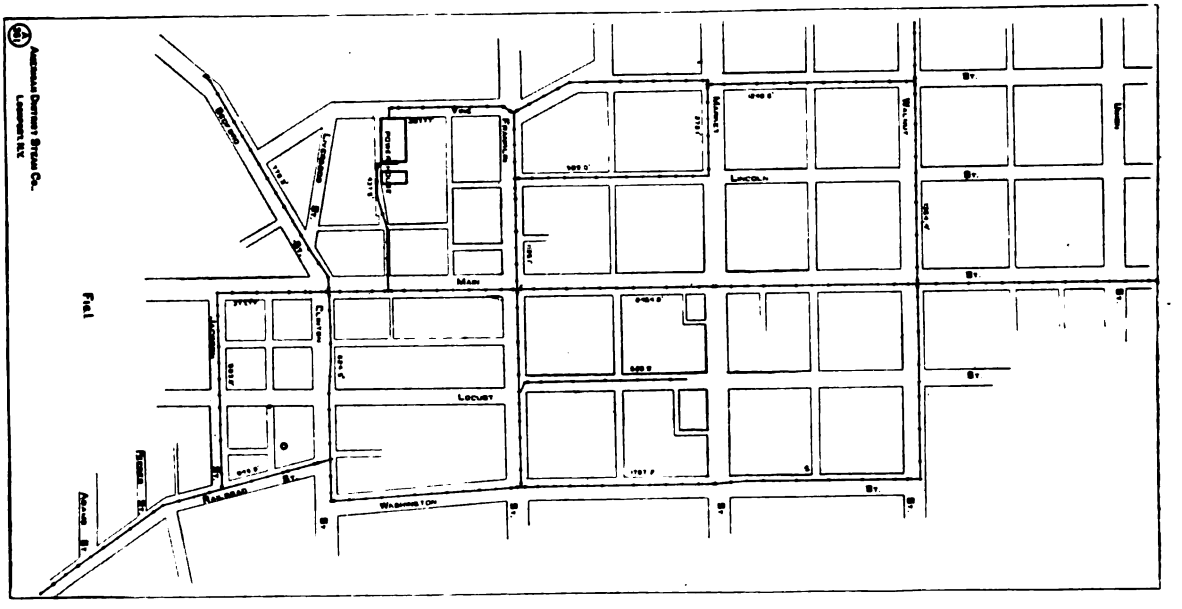

FIG. I.

Some of the results which have been secured by the Citizens' Light, Heat & Power Co. of Johnstown, Pa., from the operation of such a heating system operated in connection with their Vine street power station are shown in Fig. 4.

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In this station are located five engines as follows:

1-300 H.P. Ball & Wood engine driving 2-100 KW. generators.

1-200 H.P. Buckeye tandem-compound engine driving 2-60 KW. Edison bi-polar machines.

1-300 H.P. Buckeye tandem-compound engine driving 2-100 KW. generators.

1-300 H.P. Buckeye tandem-compound engine driving 3 No. 12 Brush arc machines.

1-700 H.P. twin Buckeye engine direct connected to 2-200 KW. generators.

In the engine room is also located a 200 KW. rotary converter and a 400 KW. motor-generator set.

Steam is supplied by 1750 H.P. in Heine water tube boilers under which are installed Murphy stokers. The boilers are also equipped with Green fuel economizers and a Pittsburg feed water heater. Worthington feed pumps take water for the boilers from both the city mains and a well on the premises.

This company also operates a power station located on Broad and Tenth Streets, known as the Broad Street station. This station is not connected to the heating system due to the fact that it is located too far away from the heating territory. The Broad Street station is equipped with two 400 KW. Westinghouse and one 1000 KW. Allis-Chalmers alternating current turbo-generators set, steam being supplied by 1200 H.P. in Babcock and Wilcox water tube boilers. The rotary converter and motor generator sets at the Vine Street station furnish the necessary connecting link to allow the transformation and transfer of current for distribution between the two stations when such transformation or transfer becomes either necessary or desirable.

The system of underground steam distributing mains, as shown in plan by Fig. 1, is connected to the exhaust piping in the Vine Street power house by one 14 in. and one 10 in. main. These underground mains now have a total length of about 13,340 feet exclusive of service pipes.

Steam heat is supplied to 294 business blocks, residences and public buildings, containing about 15,458,028 cubic feet of space, an average of 1,159 cubic feet per lineal foot of underground main being served. The size of the mains is such that all customers are amply supplied with steam with a back pressure on the engines of only two to five pounds, depending upon the demand.

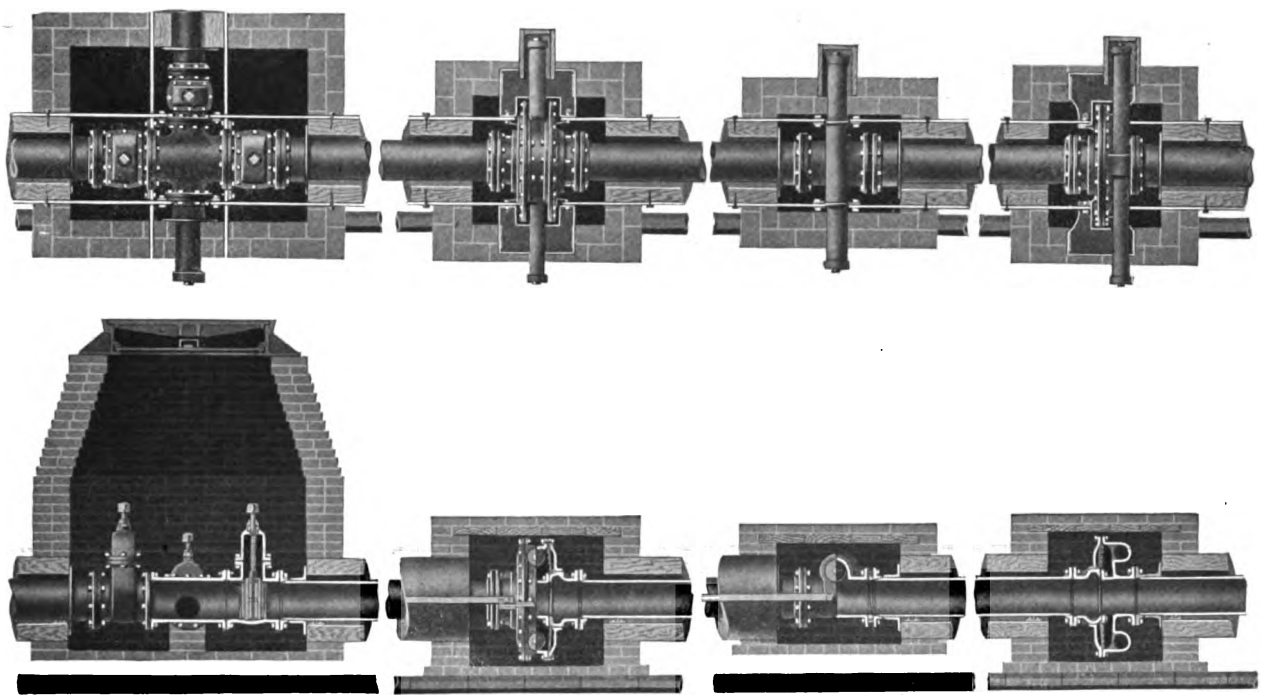

FIG. 2.

The station piping is so arranged that the supplemental supply of live steam is automatically delivered to the heating system through reducing valves during those portions of the year when the heating load is greater than can be cared for by the exhaust steam from the engines.

The underground steam mains were installed by the American District Steam Company of Lockport,

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N. Y., and Chicago, the first installation being placed underground in 1900. The service proved so attractive and satisfactory to both the consumers and operators that several extensive additions have been made until now there are more than two and one-half miles of mains installed.

Figure 2 shows a plan and sectional elevation of the various devices used for overcoming the peculiarly difficult conditions encountered in this class of underground construction. Insulation, expansion, anchorage and durability have each to be thoroughly cared for. Durability in the pipe is secured by the use of strictly wrought iron line pipe of full weight. The pipe is carefully wrapped with asbestos paper held in place by spirally wound copper wire. Between the iron pipe and the wooden insulating casing there is a one inch annular air space, the pipe being centered and supported by roller and ball bearing chains which allow free expansion and contraction with changes in temperature. The chief insulation is secured by the use of wood casing four inches in thickness. This casing is made up of kiln dried, tongued and grooved white pine staves, carefully selected so as to be free from all imperfections which might affect its durability. The inside of the casing is lined with bright tin and the outside tightly wound with heavy galvanized wire which is bound on under a pressure sufficient to deeply embed the wire into the wood. To prevent decay the whole log is covered with a heavy coating of asphaltum and sawdust. Great care is exercised when the mains are installed to drain all seepage and other water away from contact with the steam mains. For this purpose three-ply tar paper is laid on top of the casing to a point below the center line and a thorough system of underdrainage is secured by placing porous drain tile below the mains and piping same to the sewers at convenient points. The efficiency of the drainage system is greatly increased by placing the tile in sub-trenches filled with broken stone or other porous material. This careful construction results in an insulation against loss of heat so near perfection that condensation in the street mains has been reduced to an average not exceeding 5 per cent. of the total season's output, a showing worthy of comparison with gas and electric transmission losses.

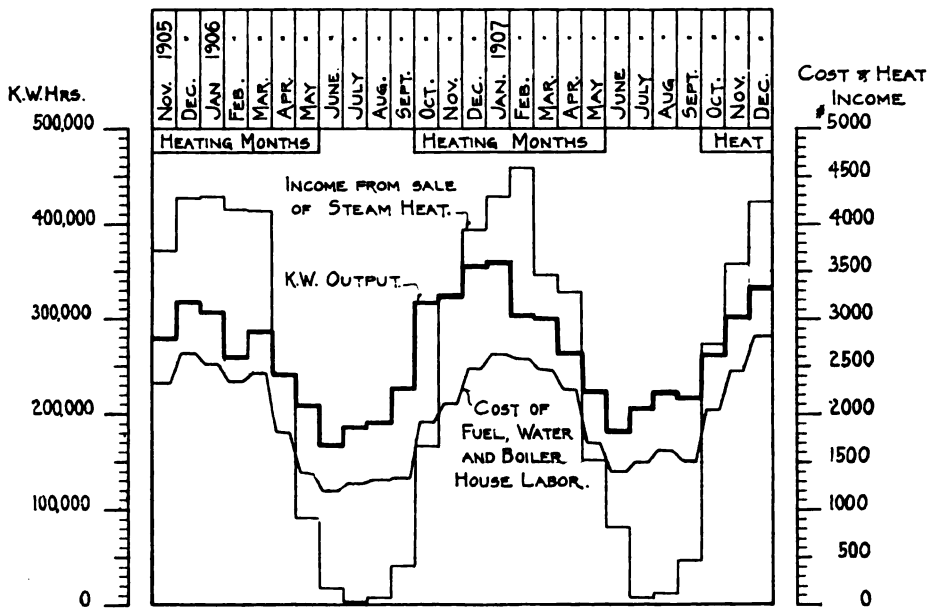

FIG. 3.

A very ingenious device known as a "Variator" is used for taking care of the expansion and contraction of the piping. This is a case or frame, securely anchored in a brick box, which holds the outer edge of a large annular corrugated copper disk, the inner edge of which is connected to the free end of the pipe. As these expansion devices require no packing or other attention after installation the street is left free from manholes except at the intersection of streets where valves are placed. The expansion devices are placed about 100 feet apart with anchorage fittings for holding the stationary end of the pipe placed midway between. Where slight changes in grade are met with an adjustable double annular wedge is placed between

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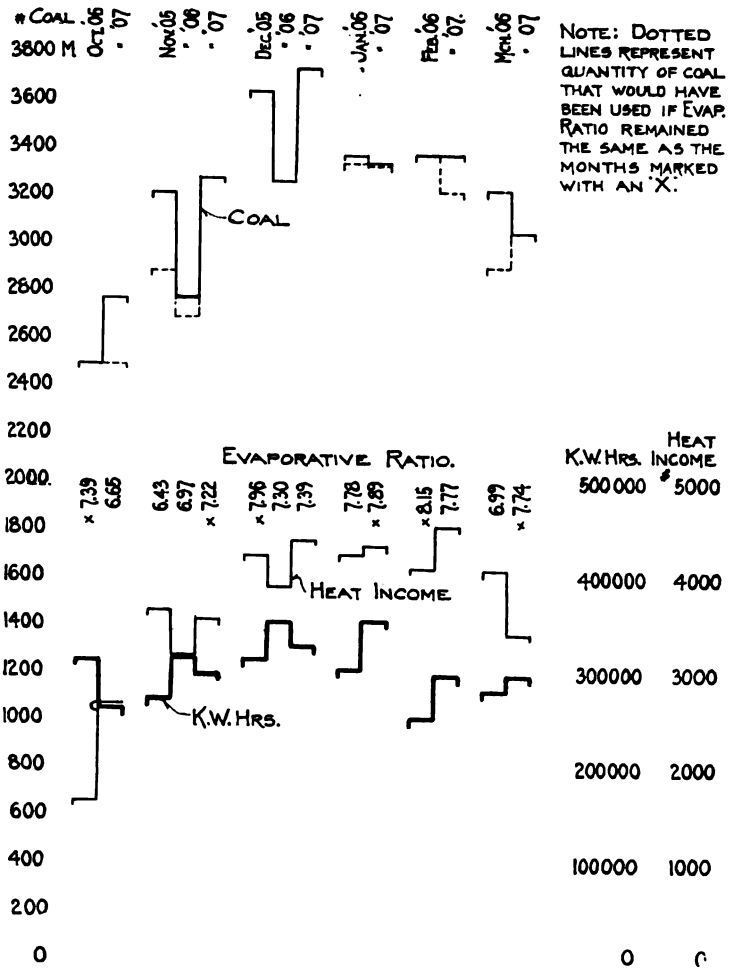
the anchorage fitting and the fixed end of the pipe. All brick boxes enclosing anchorage and expansion devices are filled with white pine or other soft wood shavings to prevent radiation of the heat.

All service pipes to buildings are taken from anchorage fittings and the stationary part of the expansion devices from openings placed above the top of the main pipe, thus securing a separator effect and insuring the delivery of dry steam to the customers. The wood casing is used for insulation on all service pipes. Flanged cross fittings are placed at the intersections of all streets so that extensions to the system may be made when the business to be secured so justifies. These fittings are made eccentric to secure the thorough drainage of water of the condensation to the low points on the system where traps are placed for its removal.

Valves are placed in manholes at the street crossings so that only small sections of territory are affected when it becomes necessary to make connections for new customers after the steam is turned on the system. The manholes have a specially constructed double cover, the inner one being provided with a ring of packing which prevents all surface water from the street coming in contact with the steam pipes. Owing to the many difficulties encountered in underground construction in city streets as well as the many points relating more especially to the laying of steam mains which are only learned through experience, it becomes necessary, when installing underground steam mains, to employ experienced engineers who have specialized this particular branch of work in order that the success of the system from a mechanical and maintenance standpoint may be assured.

Various results from the operation of the Vine Street station are shown graphically by the diagram, Fig. 3, which shows the output per month in kilowatt hours, the income from the steam sold and the total cost of fuel, water and boiler-house labor for a period of twenty-six consecutive months.

The total kilowatt hours during this period amounted to 6,856,950, of which 5,252,347 kilowatts were produced during the eighteen heating months.



- Fig. 4. -

The total cost of all fuel, water and boiler-house labor during the twenty-six months amounted to $52,138.77, the cost during the eighteen heating months amounting to $40,971.17.

The income from exhaust and live steam sold during the twenty-six months amounted to $62,962.64, and during the eighteen heating months, $60,721.92.

The significance of these figures should be very carefully noted by central station managers. The receipts from steam furnished for heating purposes during the eighteen months of the heating season paid for all fuel, water and boiler-house labor and left a surplus of $19,750.40. While this surplus was being earned there was also produced 5,252,347 KW. hours from the same fuel, water and boiler-house labor. These results are all the more interesting in view of the fact that the rates charged for steam heat at Johnstown average the lowest on record. All steam is sold by weight on the meter basis of charging which prevents loss to the sta-

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tion operator through waste by the consumer. The condensation from the radiation in each building is collected and after passing through a trap and economy coil which latter utilizes for heating purposes the heat remaining in the water of condensation, the water is weighed in a Simplex condensation meter which registers on a dial every pound of water passed.

Although there is always a greater or less amount of live steam required to supplement the supply of exhaust from the engine during the heating months, the increase in fuel consumed for heating and generating electricity is increased over the fuel required for generating electricity alone during the non-heating months less than 20 per cent. per kilowatt hour.

A study of the figures for corresponding months from which the curves shown on diagram, Fig. 3, are constructed reveals a relation of great value between the kilowatt output and the amount of coal burned in those months during which the heating load exceeds the electrical load. This relation is shown graphically by the curves on diagram, Fig. 4, from which it will be noted that with an increase in the kilowatt output, during the months in which the steam requirements for the heating load are greater than the steam requirements for the electrical load, there is a general decrease in the total amount of coal burned and this in general continues true when the quantity of coal is modified for the factor of evaporation, as shown by the dotted lines on the diagram. As far as the author is able to ascertain this same relation is found in all heating plants where the heating load is greater than the electrical load. These facts would indicate that as the power output is increased up to the point where the heating load is entirely cared for by the exhaust steam the consumption of coal will be reduced.

Much credit for the good showing from this plant is due to careful management and operation as well as the constant comparison and study given to carefully kept records.

The results obtained from this combination plant are such that the seeming advantage of power house sites placed away from the thickly built up sections of our towns and cities for the sake of cheap land, condensing water or facility in the handling of coal, entirely disappear as does also the advantage of gas engine with its much vaunted thermal efficiency, and engineers in designing plants should look carefully into the advantages of such combination systems before making expenditures for power installations in locations where such a distribution of the unused heat cannot be made.

Mr. C. S. Price is president; Mr. J. G. Ellis, vice-president; Mr. C. G. Campbell, secretary and treasurer; Mr. J. W. Reeves, general manager, and Mr. August Weis, superintendent of the Citizens' Light, Heat & Power Company. The author wishes to express his thanks to the officers of the Johnstown Company for their courtesy in furnishing the facts and figures from which this article has been compiled.

The Electric Vehicle in Central Station Practice

By R. McA. Lloyd.

The managers of electric light companies are accustomed to hear an annual blast from the manufacturers of electric vehicles, sounding the praise of electrics, announcing that all the problems have been solved, and that the time has arrived for the electric vehicle to sweep horses from the streets, turning the stream of gold from the dealers in hay and oats to the purveyors of electric current, but still the oats man prospers, and, what is more to be regretted, the gasoline man fattens on ill-gotten gain.

Will the electric vehicle ever take the place in electrical engineering which was hoped for by its advocates some years ago? We think it will. The number in use has steadily, if slowly, increased in many towns and cities for which it is adapted, and it has become already a considerable factor in the income of many electric light companies. It must not be judged, however, by the average results of the last ten years any more than gasoline vehicles should be judged by their average performance over the same period. They have both been going through stages of development and have both become, to a great extent, standardized, and they are both here to stay. They should be studied together on the basis of what the latest and best of them can do, without reference to the past or to poorly constructed models.

It is not necessary to go deeply into the merits of gasoline pleasure cars. Every man either has

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one or expects to own one sometime. It is hardly necessary to refer the electric pleasure vehicles; every woman wants one, and even the men find them convenient adjuncts to the family stable. It is in regard to the business wagon that the question is raised, and the seriously minded business man finds difficulty in deciding whether the horse, gasoline or electricity is best for his pocket.

The fact is now generally recognized that the horse is about to be displaced. It is also conceded that there are many uses for the gasoline wagon which are beyond the aim of the electric; but in great centers of population where the greatest work is done which is the best?

It should not be difficult for the engineer to decide. If you take the best gasoline and the best electric vehicle for any given work up to five tons carrying capacity, you will find that weight and first cost are the same. In operation, the cost of gasoline and lubricating oil more than offsets the cost of electric current.

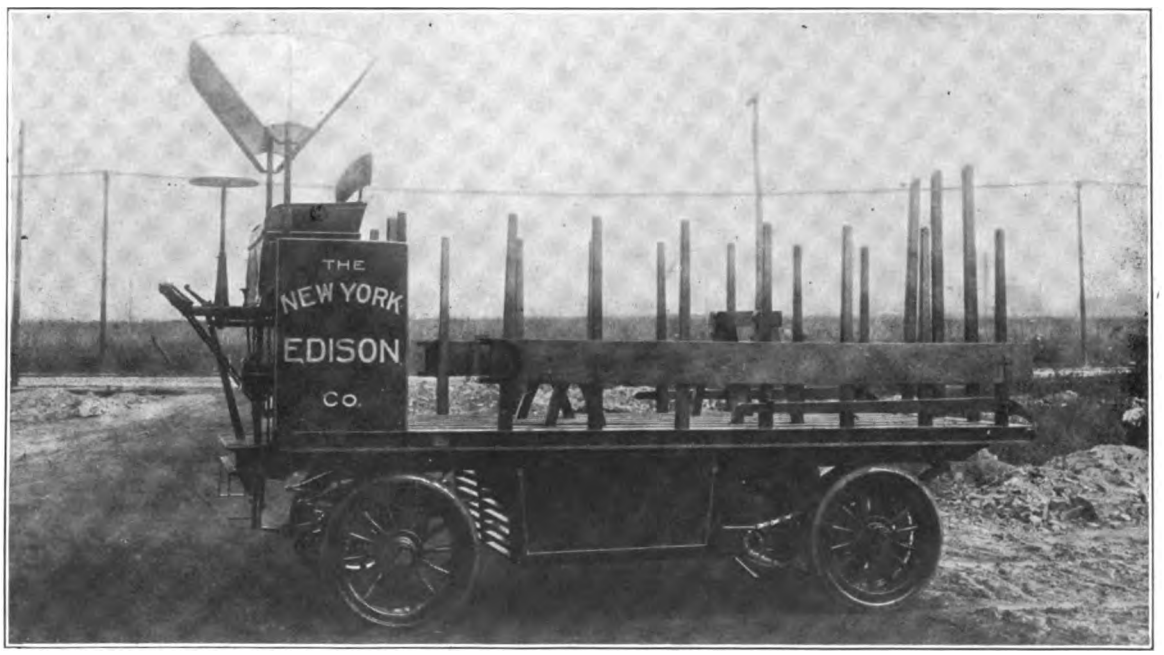
In up-keep, they both have axles, wheels, tires, brakes, springs, steering gears and chassis-frames of equal cost to maintain, but one has an engine, transmission, pump, pipes and tanks while the other has a battery, electric motor, controller and wiring.

The driver of one gets two dollars per day, the driver of the other gets three. They both do the same work in a day.

Leaving out the drivers, it is only necessary, therefore, to determine the comparative cost of maintenance of the battery, motors, controller and wiring in one case, with the engine, transmission, pipes, tanks, etc., in the other.

We know to a certainty the cost of maintaining the electric equipment and are quite as positive that the cost of maintaining the gasoline equipment is greater;—how much greater has not yet been determined.

We also know that the interruptions to service in the case of the gasoline vehicle are more numerous and serious than with the electric. We know also that in many minor points, the electric has the advantage. It is cleaner, easier to operate, less disliked about freight yards, warehouses and inside of stores at shopping quarters; it is more fireproof, and a vastly more desirable insurance risk.



What, therefore, is the advantage to be derived by the merchant in using the gasoline wagon as against the electric? I cannot detect it, and frankly believe that a large part of the electric fraternity are being carried away by the chorus of gasoline voices against the solos and quartettes of the electric vehicle manufacturers.

If the electric-light managers will consider the electric vehicle of to-day, and carefully figure out the whole proposition for themselves, along the lines suggested above, they will come to the conclusion that, after all, electricity is the best power and one worthy of their best efforts in the furtherance of its application.

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Central Station Light, Heat, and Power Principles

By Newton Harrison.

The Fuel of Stations.—The fuel generally consumed in central stations is coal. In addition to coal, oil has been used which is found in many instances to be convenient and economical. Another form of fuel is natural gas or producer gas, which seems to fill the bill in many particulars, economically and practically. The point of interest about fuel is naturally the number of heat units it contains per unit of weight or volume. In the case of gas, it is presumed that a gas engine is used suited to the type of work demanded of it. In other words, the gas engine suitable for a central station would be capable of excellent regulation in addition to being an economical element of the plant. The reason why various fuels must be considered is because of the dependence of the plant for its success upon two general items: one is naturally the cost of the fuel itself, and the other is the labor bill and other fixed charges. But in connection with the fuel itself, it is necessary to realize that a large central station must know, when selecting the particular kind of coal for its boilers, what this coal can do in the way of producing units of heat. It must be remembered that the more coal a boiler consumes, the faster that boiler is wearing itself out. The consequence is that when a choice of fuel is to be made, that fuel of which the least may be consumed in producing the greatest number of heat units, is unquestionably the best to purchase. On the other hand, a fuel which is wasteful in the sense that it is productive of much ash, which is also associated with the element of labor and does not produce very much heat, involves a triple cost: First, that due to its handling; second, that connected with its combustion and forming part of the item of deterioration; and third, that connected with the handling of the ashes.

Where oil is concerned, other questions arise, such as the proper number of square feet of heating surface to the boiler, and the correct type of oil burner selected with respect to safety, economy and utility. There are not many cases extant of oil being used for the running of very large plants. To some extent, this phase of central station work is somewhat undeveloped; but it is evident at a glance that oil serving as the heating element in a plant must be handled under about the same general conditions as if it were used for other practical purposes. The risk of conflagration is present to a somewhat greater degree than otherwise, unless the oil is of such a character that its combustion is only insured in connection with a generous supply of air under pressure. The real proposition is found in the application of gas for the development of power, or the reduction of oil into gas which is used explosively in an engine.

Producer Gas.—Producer gas is that obtained from a gas producing plant which can utilize low grades of coal and distil the gas useful for central station work in gas engines. Government tests have demonstrated the fact that more than twice the cheapness results from the extraction of the energy of coal in this manner in lieu of the direct combustion of coal in the boiler as ordinarily understood. In case a gas engine plant is installed, the point of vital interest is that relating to the cost of the fuel as a basis of energy. It may be understood that the cost of producing electrical energy varies and cannot be considered as belonging to any one item, for the simple reason that the fuel, the labor bill, the wear and tear and the expense due to improvements or accidents must be included. Therefore, it is evident that the cost incident to the running of a complete plant including everything must be established by a consideration of these items in addition to the interest on the total investment. For instance, a million dollars subscribed for the complete erection of a plant would necessarily call for the payment of an annual interest item of fifty or sixty thousand dollars. On this basis, it is easy to see that earnings must be made to not only pay the detailed expenses and the interest charges, but sufficient profit to insure absolute success. A ton of coal for producing steam in the regular way by ordinary methods of combustion, would represent a certain watt output at the switchboard. It is admitted in many quarters that the same amount of coal distilled in a gas producer plant, and the gas as thus obtained used explosively in an engine for the development of mechanical power, is able to give a watt output at the switchboard of more than twice as much as in the previous case. While it cannot be claimed that the whole success of a plant depends upon the limited cost of fuel, and therefore of the electricity produced, it must be admitted that, in the case of two stations of equal earning capacity, equal expense and equal size, the one paying the least for its power is probably the one which will make the

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most money. The handling of the technical details of a central station are of concern to the stockholder, or bondholder only in so far as the intrinsic value of the securities they hold are affected. In consequence of this the accumulated result of neglect, bad administration and poor engineering would seem to come suddenly, whereas might readily be discovered to have developed only in the course of a great many months.

Wear and Tear in a Station.—The wear and tear in a central station might be said to be widespreal and include almost everything pertaining to that category, with the exception of the four walls and roof. In some cases, it may even be shown that the vibration has been the means of weakening the building and bringing about conditions which, from the builder's and architect's standpoint, require attention. Otherwise, the wear and tear may be simply considered with respect to the boilers, engines, dynamos, switchboards and other machinery employed. That wear and tear is inevitable and will show its effects is impossible to deny, and in consequence of this it is customary to make allowances included in the cost of producing electrical energy, so that correct power estimates may be made. To accomplish this it is necessary to employ a system of bookkeeping based upon a rational view of the operation of the plant. Bookkeeping which includes only the cost of fuel, labor and some other few items is false and therefore misleading. The proper form of bookkeeping would be that which takes into consideration all items that contribute to the establishment of an expense in connection with the running of the station. It would be hard to say just how long a building used for the housing of a central station plant would last. But it is not so much the actual wear of a station that must be considered as the fact that the advance of electrical engineering calls for its redesign, and consequently the plan of a station and its construction ten or fifteen years ago was very much different from what it is to-day. In this respect, changes are forced upon the stockholders in order to compete with new conditions that arise, and operate the plant more favorably than before. For instance, coal which might have been used in the lower part of the building is now hoisted to the upper part and there permitted to fall through gravity to points where it is to be used. If the upper part of a central station is to hold some hundreds of thousands of tons of coal, it is quite evident that the walls must be thickened, the steel construction must be improved and the general architecture modified to meet this new strain. Therefore, expense involving a considerable new investment must be made to yield not only its quota of interest, but also its element of profit as a sign of the increased earning capacity of the plant.

Whether gas engines or steam engines are used, the wear and tear involved is such that their actual period of useful life is limited to a certain number of years. While many engines do their work day after day without interruption, the time eventually comes when they must be stopped and certain repairs made in order to guarantee their future successful operation. The gas engine is peculiarly susceptible to certain influences and must be well watched in order that it may continue to be serviceable. If a gas producer plant also forms part of the equipment, there is another item of investment, a bill for labor, fuel and repairs, which must be considered. The wear and tear, therefore, include the part producing the source of mechanical energy, the prime mover so-called, the generators and certain parts of the switchboard.

In connection with the boiler, the steam engineer knows only too well the damaging effect of mineral carrying water upon its interior. In sections of the country where the water is very limy, boilers are readily injured by the evaporation going on inside, which leaves a heavy residue of solid matter. In consequence of this, an element of wear and tear in the boiler is determined not only by the effects of a powerful heat playing upon it for many hours a day, but also by the deleterious effect of dissolved mineral matter in the water, which thus forms a scale difficult to remove. Boilers may be readily ruined by carelessness or neglect in this respect, and here at least may be found an item of expense constituting wear and tear which is hard to eliminate. Perhaps the least effective of all the machinery in the central station equipment is the generator proper. This cannot be said of the switchboard, for the simple reason that instruments are affected in the course of time, accidentally, if no other way, by the current, and thus require repair and calibration. In the following table, items are given relating to the maintenance and operation of a central station with respect to their charges, and showing the comparison to be made between reciprocating engines, steam turbines, gas engine plants and composite plants using both reciprocating engines and steam turbines, and gas engines and steam turbines. The table is taken from the transactions of the American Institute of Electrical Engineers, and was prepared by Mr. H. G. Stott:

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DISTRIBUTION OF MAINTENANCE AND OPERATING CHARGES.

	Maintenance.	Reciprocating Engines.	Steam Turbines.	Reciprocating Engines and Steam Turbines.	Gas Engine Plant.	Gas Engines and Steam Turbines.
1.	Engine room mechanical	$2.57	$0.51	$1.54	$2.57	$1.54
2.	Boiler room or producer room	4.61	4.30	3.52	1.15	1.95
3.	Coal and ash-handling apparatus	0.58	0.54	0.44	0.29	0.29
4.	Electrical apparatus	1.12	1.12	1.12	1.12	1.12
	Operation.					
5.	Coal and ash handling labor	2.26	2.11	1.74	1.13	1.13
6.	Removal of ashes	1.06	0.94	0.80	0.53	0.53
7.	Dock rental	0.74	0.74	0.74	0.74	0.74
8.	Boiler room labor	7.15	6.68	5.46	1.79	3.03
9.	Boiler room oil, waste, etc	0.17	0.17	0.17	0.17	0.17
10.	Coal	61.30	57.30	46.87	26.31	25.77
11.	Water	7.14	0.71	5.46	3.57	2.14
12.	Engine room mechanical labor	6.71	1.35	4.03	6.71	4.03
13.	Lubrication	1.77	0.35	1.01	1.77	1.06
14.	Waste, etc	0.30	0.30	0.30	0.30	0.30
15.	Electrical labor	2.52	2.52	2.52	2.52	2.52
	Relative cost of maintenance and operation	$100.00	$79.64	$75.52	$50.67	$46.32
	Relative investment in per cent	100.00	82.50	77.00	100.00	91.20

Financial Efficiency of the Station.—It is rather difficult to decide upon the exact term to apply to a station representing a certain investment, having a certain capacity and yet producing but a limited income—less than it should. The difficulty in station practice from a financial and business standpoint is that the station is not always earning its salt. A certain investment may at times earn much more than it should, and at other times much less. By this is meant that central stations are affected by what may be called overloads and underloads. At one time of the day their capacity is stretched to the breaking point, and at other times the station hardly pays its expenses—maybe not at all. The difficulty existing, therefore, is that found in running a station so that it averages up well. And an even better thing than this to do is to secure business for the station so that the load-line does not vary greatly during the "rush" hours, and the lighter hours of load. The academic plan is that of installing a storage battery which naturally represents an additional element of expense, care, depreciation and labor, and using it for the preservation of the load-line to a higher point than it would otherwise be when the demand is light. When the call on the station is at its greatest, then the storage batteries are employed for the purpose of lowering the peak of the curve.

The business situation confronting the central station manager is one which makes a demand upon him to get such contracts for current as will fill in the depression, in the load-curve and, to a certain extent, reduce the peak as much as possible. In order to attain this object, careful canvassing of districts is necessary, and an agent must have the right idea implanted in his mind before setting out. Other schemes have been developed with respect to special rates for current, so that the load on the station is preserved as uniform as circumstances permit. In spite of such efforts, however, many central stations suffer from a lack of work to do, that is, currents to supply, during certain hours of the day, and from inability to meet the demand without greatly increasing the investment in the equipment during other hours of the day. In such instances where a central station can conduct additional enterprises, which call for the consumption of current, it is possible to so arrange matters that the original investment in the plant is made to pay better. But in larger cities this is rather difficult and in consequence the above problem presents itself in the majority of cases.

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Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Liability for Death or Injury from Electric Current, Continued—Duty and Liability to Licensees and Trespassers—Employees of Other Companies, Continued

In the last article the case discussed presented upon a novel state of facts an illustration of the rule regarding the duty and liability to employees of other companies with respect to the negligence of the defendant.

A comparatively recent case in New York is an illustration of the correlative rule requiring the plaintiff or plaintiff's intestate in case of injury causing death, to be free from contributory negligence. In this case it appeared that the employee of one company came in contact with wires supported upon the same pole by different cross arms, but close to the wires of the company which deceased was engaged with by reason of defective insulation. The court considered the deceased guilty of contributory negligence. The court also held that there was no duty owing the deceased on the part of the electric company to have the wire at the poles where the injury occurred properly insulated. Continuing the court said:

"But if it did owe the duty of having the wire properly insulated, the intestate was still charged with the exercise of reasonable care. He was a man of mature age; he was employed in connection with wires carrying electricity. If he were injured because the insulating material was not intact, such defect was as apparent to him as to the demurrent. His point of contact must have been identical with the defective place in the covering. He came in touch with it not inadvertently or from necessity, but deliberately and intentionally. He, therefore, cannot establish his freedom from negligence, unless he had a right to speculate as to whether or not the covering was defective. Can it be said that a reasonably prudent person will intentionally put himself in contact with a wire carrying a deadly current of electricity, knowing that nothing stands between himself and its deadly power save a thin and flexible layer of insulating material liable to become impaired by exposure or erosion or abrasion, without inspecting the point of contact? I think not. It is a matter of common knowledge that the best insulation is at times and under certain conditions entirely inadequate. When a person purposely puts himself in contact with such a dangerous thing, he may not be indifferent as to whether its owner has or has not done all he ought to have been. He must be held to the degree of care that is imposed upon all persons who intentionally deal with dangerous things. In this case the intestate must be regarded as knowing the purpose for which the wire was employed, the dangerous current conveyed by it, the liability of its covering becoming impaired by use and exposure or by coming in contact with hard substances, and the uncertainty of its effective operation occasioned by dampness or other causes beyond control, and, therefore, as running his chances when he put himself in contact with it without taking any active measure to determine its actual condition."

Mangan vs. Hudson River Telephone Co., 100 N. Y. Sup. 539.

We thus have two illustrations of each of the correlative rules. We will now devote our attention to a consideration of some cases illustrating the rule of liability.

Where a telephone employee is sent to correct a difficulty with the telephone connection, ascended it and was killed by a current over a circuit formed by the attachment of a hay wire to a step of the telephone pole and connected with a guy wire of an electric pole, it was held that the city which owned the electric pole was liable for suffering the connection to be made, and it was declared that there was no apparent danger from the attachment of the hay wire and therefore the deceased was not guilty of contributory negligence.

Yazoo vs. Birchett (Miss.) 42 S. E. Rep. 569.

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A case illustrative of the same doctrine, although not on similar facts, is that of Brush Electric Light & Power Co. vs. LeFevre. In this case plaintiff and his son were engaged in moving a house through a public street. The plaintiff went upon a porch or awning to assist the son in raising the wires so as to prevent them from interfering with the house. The father was shocked and lost consciousness. The son went to assist him and after he had regained consciousness he was left by the son but became dizzy and fell against the wires, involving the son in his fall. The son caught hold of the wires and was killed. The court held that the failure of the electric company to have the wires properly insulated at that point was negligence; that the fact that he involuntarily seized the wires to keep from falling was not contributory negligence, nor was the fact that he was on the awning or porch to help his father, who had been injured by a current of electricity, such contributory negligence as would prevent recovery either on the part of the son had he survived or on the part of the father suing for the injuries causing his death.

The question of contributory negligence is always of importance in these cases and must of necessity depend upon the facts of each particular case. The general rules we have already emphasized. It remains to apply these general rules and that is a question for the court and jury.

In Martin vs. Citizens General Electric Co (Ky.), 92 S. W. Rep. 547, it appeared that a lineman in the employ of the defendant company was sent out to put a cross arm on one of its poles. Right by the pole of the defendant company stood a pole of the Louisville Electric Light Co. These two poles were so near together that one could not go up between them. Martin climbed the pole of the Louisville company. Both of these poles carried a very strong current of electricity and the pole of the Louisville company carried telegraph wires above the electric wires. After Martin had gotten on the cross arm which bore the high tension wires he stood up on the cross arm and took hold of a rope to throw it over the wire. His hand came in contact with the telegraph wire and he received a shock which severely burned him and threw him to the ground. The case involved the General Electric Company, the Louisville company and the Telegraph company. The court directed a verdict in favor of the telegraph company on the ground that there was no evidence tending to show negligence on their part, although it was contended that there was probably a short circuit somewhere from the crossing of their wires with the electric light wire, but this was considered too speculative. The jury found in favor of the defendant and the Supreme Court said that in view of the testimony it believed Martin to have been standing on one of the high tension wires, considered him guilty of contributory negligence and sustained the verdict. They said, in part, that Martin knew the dangers of the situation, knew the electric light wire to be charged with a strong current of electricity, could see the wires about him, knew the danger of making a short circuit if he placed his foot on the electric light wire and threw his hands about the other wires and therefore considered that the jury were justified in finding him guilty of contributory negligence.

Liability—One Injured by Electric Current While in Another's House on Business

In this case it appeared that "defendant was engaged in the business of manufacturing and supplying the citizens of Fargo, N. D., with electric current for light and power purposes. One Stone was a customer of the company. His residence was equipped with the requisite fixtures, and the company was supplying it and particularly the basement with electric light. Prior to September 2, 1905, the date of the casualty in question, Arntson, with one Davenport, had been employed by Stone to install a new furnace in his basement. The work had been nearly completed the night before, so that Arntson's services were no longer required there, and he left without taking his working tools away. At about noon of the next day he was directed by his general employer to go and get his tools for use elsewhere. In obedience to that direction, he went into the basement and while there gathering them up received a shock of electricity which resulted in his death. The evidence shows that the shock was occasioned by an excessive current of electricity which had been negligently allowed by defendant to flow into the basement. The transformer which reduced the primary current of large voltage to one suitable for lighting purposes was out of order, and permitted the deadly primary current to flow over the latter. Defendant was notified of the trouble."

Upon this state of facts the court said, in speaking of the defendant, that "it was its duty to act promptly, and immediately cut off the current until the defect could be cured and danger averted. This is not denied by defendant. Negligence is practically conceded but defendant challenges plaintiff's

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judgment on the grounds (1) that in the circumstances disclosed by the proof it owed no duty to Arntson, and therefore could not be guilty of any breach of duty; (2) that notwithstanding defendant's negligence in permitting the current of deadly voltage to enter the basement Stone's possession of the fixtures in the basement and his duty in relation to them interposed an efficient and proximate human agency between defendant's negligence and Arntson's injury and caused the latter; (3) that Arntson was guilty of contributory negligence which precludes recovery. We think all these contentions are untenable.

1. Defendant owed a duty to its patron Stone to exercise a proper degree of care to prevent a dangerous current of electricity from entering his dwelling. This duty on the plainest principles of law and common sense extended to his family, his servants, his employees, and others who might rightfully be upon his premises. The current was a subtle and dangerous agent, and when uncontrolled was such as might be fatal to any occupant of a building in which it might be installed. This the defendant must have known, and it must have known what everybody else knows, that servants, artisans, and workmen of one kind or another are liable at times to be within the building in the customary and proper discharge of duty. The evidence conclusively shows that Arntson was such a workman. He had been employed in performing a usual and customary duty for Stone, renewing his heating apparatus and making the house ready for the approaching winter. Having finished his part of the work he returned to gather up his tools for use elsewhere. He was required to go into the basement where he had used them and left them. That the defendant should have fairly and reasonably anticipated that the basement which it had equipped with wires and lamps for lighting purposes would be occupied and used as it was and that Stone's agents, servants, and employees might from time to time be there is not debatable, and that defendant owed a duty to exercise a proper degree of care for their safety, is beyond question. If authority were necessary to sustain so plain a proposition, reference might be made to 1 Thompson on Negligence, Sec. 801 et seq., and to the cases there cited.

2. Stone's ownership and control of the building presented no such intervening human agency between defendant's negligence and the injury of Arntson as precludes recovery in this case. No view of the facts warrants the conclusion that he had any relation to the injury whatsoever. It was out of his power to prevent it. It was the current of electricity generated by defendant's dynamo, and under its exclusive control and operation, and not the dead and harmless wire and lamps in Stone's possession, disconnected from the live current, that caused the injury. Defendant's obligation to Stone's family, servants, and workmen was a primary and continuing one. Neither Stone nor any of them could guard themselves against a failure to perform that obligation. They necessarily had to take and use the current trusting to the efficiency, care and watchfulness of defendant company. For interesting and instructive cases on this subject, reference may be made to Memphis Consol. Gas & Electric Co. vs. Letson, 135 Fed. 969, 68 C. C. A. 453, and cases there cited.

3. Did Arntson by his own negligence contribute to the fatal injury which he received; or to put it more aptly, for the purposes of this case, is the evidence so conclusive that his negligence did contribute to his death that the jury could not lawfully have found to the contrary? The burden of proving contributory negligence rests on the defendant, and, in order to justify a directed verdict in its favor on that issue, the facts must have been such that all reasonable men in the exercise of an honest and impartial judgment would have found such negligence. Such is the well-settled rule of law. What are the facts? During the forenoon of the fatal day before Arntson returned to the basement for his tools one Worth, an employee of Stone, went into the basement where Davenport was finishing the installation of the furnace, and while attempting to turn on one of the electric lights which was there received two successive shocks of considerable severity. Defendant company was at once notified of that fact, and sent an expert representative to give it attention. He made the investigation, and reported back to the company. Some two or three hours after Worth's experience Arntson appeared to get his tools, and was fully informed by Davenport about the events of the morning. In connection with the narration, he was told that the expert had been there some two or three hours before, and had gone away. There are facts involving some detail unnecessary to relate from which the workmen might reasonably have believed that the trouble which Worth experienced arose from some temporary defect in the insulation of one of the extension wires connected with one of the lights in the basement. There was evidence tending to show that, while Davenport was narrating Worth's experience in the morning, Arntson was looking about for his

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tools. He undertook to turn on one of the lights, and while doing so remarked, 'I always take hold of a light that way,' and instantly received the fatal shock. Defendant contends that it appears from this kind of evidence that the deceased knew from Davenport's narration of Worth's experience that something was out of order, and that the lamps or wires could not be touched with impunity, and that Arntson was experimenting of boasting of his ability to do with impunity what Worth failed to do when he received the shock, and that by so doing he voluntarily subjected himself to known danger, and is not entitled to recover. Plaintiff, on the other hand, contends that a fair inference from the evidence is that Arntson had reason to believe and believed from the fact that defendant's expert had been there and gone away and from other facts in the case, that the trouble of the morning was only temporary and trifling, and had been effectually cured by the company's expert, and that he undertook to turn on the light, not as an exhibition of recklessness, but in order to aid him to discover the location of his tools and enable him to gather them up. In our opinion the evidence referred to and all other evidence bearing legitimately on the issue before us presented a fairly debatable question of fact, one about which reasonable men might honestly and fairly differ, and one which might reasonably and plausibly be found either way. Whether or not the deceased was guilty of contributory negligence depended largely upon circumstantial evidence. Because of the average man's familiarity with facts of every day life and of the reasons and motives which actuate human conduct, the issue in question was peculiarly one for the jury. They could best determine the significance of the facts and the reasonable inferences to be drawn from them.

Union Light, Heat & Power Co. vs. Arntson, 157 Fed. Rep. 540.

Steam Engine Business

Whatever may have been the cause of industrial depression the signs of recovery from it are unmistakable in the recent sales of new machinery equipment to manufacturing plants in various parts of the country. This revival is general all along the line of commercial activity, for orders for steel are said to have increased 25 per cent. over a month ago. Railroad earnings are better for several of the larger systems and building activities are much more active.

Sales of Allis-Chalmers Corliss Engines, mainly with electric generators and other equipments, made recently in several parts of the country, bear out this statement.

The Chouteau Power and Milling Company, of Chouteau, Montana, has ordered a 12 x 24 in. Reliance engine, horizontal tubular boiler and engine room auxiliaries for installation 30 miles from Collins, Mont., and overland away from the railroad. The engine is to be equipped with the standard Reynolds Corliss liberating valve gear and will operate at a speed of 134 R.P.M., non-condensing, at a steam pressure of 125 lbs. The engine is to be belted to an alternating current generator and a line shaft operating flour mill machinery. The boiler has 100 H.P. capacity and a working pressure of 125 lbs.

The Gooch Milling & Elevator Company, of Lincoln, Neb., has awarded contracts for the equipment of a new 200-barrel flour mill to Allis-Chalmers Co., including a 14 x 36 in. Reliance engine and a small electric lighting equipment. The flour mill machinery includes a number of 9 x 24 in. roller mills, both smooth and corrugated, universal bolters, Reliance purifiers, centrifugal rolls all standard Allis-Chalmers equipment.

The engine is designed to operate at a speed of 100 R.P.M., non-condensing with 120 lbs. steam pressure.

The American Cotton Oil Co., of New York City has recently purchased for installation at West New York, N. J., a 16 x 30 in. Allis-Chalmers Reliance Engine to operate at 120 R.P.M., non-condensing, with 80 lbs. steam pressure.

The New Jersey and Pennsylvania Traction Co. of Trenton, N. J., has let contracts to Allis-Chalmers Co. for supplying a 24 in. and 48 x 42 in. heavy duty cross compound engine, an 800 kw. alternator and a 35 kw. induction motor driven exciter for installation at Yardley, Bucks County, Pa.

The Tyee Copper Co. of Ladysmith, B. C., will install a 12 in. and 24 x 30 in. Reliance cross compound engine and a new Allis-Chalmers Smelting furnace in the smelting works at Ladysmith. The engine is designed for driving a Connersville blower.

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Prepayment Meters

The prepayment of current, like the prepayment of gas, meets a demand made by the small consumer for that quantity of the product which can be paid for by a small coin. For such a purpose the use of a specially constructed meter is necessary, and sufficient customers of this class to make such an undertaking worth while. It naturally represents a type of business which could not otherwise be obtained, except by such a system, as it is of a variable, intermittent and sometimes unprofitable character.

The interesting aspects of the case are twofold, to present the points didactically: First, as a source of income otherwise unobtainable; second as a form of missionary work which not only introduces the use of the current, but saves the troubles incident to collections by the advantageous form of meter employed. It may be said that the vast number of people in the United States who have never used electricity for light and power are not necessarily non-users simply because they are antagonistic to its introduction. They are of a class that can be readily led to entertain its use, if the proposition is put to them in such a form as to be sufficiently interesting financially.

There is a fear on the part of many people, not so much due to the charges for current, which must necessarily occur, as due to a vague and rather ill-defined fear of bills that they would be poorly prepared to dispute. Their general idea being capable of representation as risk and expense on the one hand, and being "in for it" on the other hand, when they put their signatures to a contract for current. To such as these, the eloquence of a prepayment meter stands unparalleled. They are not bound by conditions they believe they do not understand and which in consequence assume the proportions of a rather large responsibility in their eyes. The game, to put it in the vernacular, is "straight" and perfectly fair, as any rational mind could easily ascertain. The dropping of a sum of money into a meter of this type insures power under such conditions that criticism is absolutely impossible in connection with its use.

The meter may and should prove a source of liberal education to those employing its services. It is extremely valuable as far as establishing acquaintanceship in the consumer's mind between watts and their cost, as may be readily noted. It shows the number of lamp hours or quantity of light and the relative expense attached to such illumination by the fact that it supplies a given amount of power for a given time, when a coin is dropped inside. In other words, it readily establishes a principle of definiteness in the customer's mind, so that the veil of mystery supposed to exist is torn aside for good and all, and the practical facts appear as they should always appear in their true light.

From a business standpoint, and that is really the standpoint that should be observed fundamentally in all central station work, there is no reason why possible small consumers should not be given a chance to invest part of their limited means in electricity. Sometimes the reason why the poor don't seem to get a share of the good things of life is because

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they seem to be too expensive. This is evidently a mistake in such instances as those which permit indulgence, but to a more limited extent than is usual. Prepayment meters from this standpoint would undoubtedly prove the means by which those with dimes and quarters to invest could get returns that would be at least financially satisfactory. Between pauperism, poverty and limited means, sufficient difference exists to indicate where prepayment meters may secure business returns. It would be unwise to install them except where the locality has been thoroughly canvassed, and even then it would be necessary to arrive at some conclusion as to the net returns before such a proposition would be really ripe for carrying into effect.

Restrictions Regarding Water Power Plants

Certain conclusions seem to have been reached by the National Government regarding water power and the restrictions that should be placed upon its use. Hitherto, no limitations were imposed which in any way interfered with the utilization of ths force of nature, and in consequence the promoters of such enterprises found it unnecessary to consider national requirements on this score. But the President, in a special message to Congress dated April 13, strenuously insists upon the property rights of the central government in all future water power transactions and desires a price to be set on such grants which were hitherto obtainable for nothing.

In his estimate of the power represented by streams and rivers, about 1,300,000 horse power was indicated. He claims that horse power approximating such figures represents a matter of 25,000,000 tons of coal consumed annually. He believes that this should be paid for by those entering into water power enterprises and makes the statement which is here quoted: "This natural wealth is the heritage of the people. I see no reason for giving it away."

The idea dominating the phraseology of the President's message of the date given is that the national government should be in receipt of an income from all such grants of this character. He believes in the principle that the people of this country own all natural sources of power, and in consequence as their property it must not be given away, but rented. If rented, he claims that the returns could be used for the improvement of such waters as are navigable and thus aid in the development of commerce to a marked extent.

The conditions expressed by President Roosevelt seem to be covered by five points which may be presented in the following manner: The first limits the period of usage; the second gives the government the power to break the contract, if the contracting parties do not live up to the letter of their agreement with the government; the third calls for official inspection of the navigation these conditions affect, and also demands inspection of the plant for the purpose of seeing whether the power developed approached a maximum. The fourth point covers the license fee or charge, and the fifth specifies the conclusion of the agreement at whatever time is fixed upon.

The use of water power generally implies the utilization of such electrical machinery as is necessary for the conversion of mechanical into electrical energy. In consequence, the message seems to have a direct bearing on such central stations and power plants deriving their energy from sources of water power. It becomes a point of Federal law to decide upon the permanence of agreements made with the government prior to the legislation enacted, or to be enacted to govern these conditions. Whatever the outcome may be, it is quite evident that the license fee or annual charges must not be such as to seriously interfere with the progress of enterprise in this respect. No true American can object to paying a fair price for a fair thing, but any legislation which tends to throttle a field of activity indispensable to the interests of large communities, would not only be unjust but probably pave the way for its own ultimate elimination. It will be interesting to the promoters and backers of central station enterprises to view the final form of legislation adopted. If any "kicking" is to be done, it will probably be most necessary then; otherwise, the Washington suggestion will probably be received with attention and interest and affect all future propositions involving the use of large water powers.

In Switzerland, water power plants are found on every side. By means of this adaptation of nature to the needs of man, considerable fuel that would be otherwise consumed is saved. There is no real reason why we should use as much coal as we do, when such sources of power are at hand. But it must not be forgotten that in some cases, as that of Niagara Falls for instance, whether the power is there or not, legislation is enacted against its use for esthetic reasons, so that those purely industrial or economic are not the only ones to be considered.

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Fire-Proofing Central Stations

Conditions exist in central stations which demand a regard for fireproofing somewhat superior to that which is termed normal in other cases. The reason why special precautions are necessary, is not difficult to find if but a moment's consideration is given to the comparatively large quantity of power housed under the roof of a central station. The fireproofing, in consequence, must be as much negative in its nature, that is to say, remedial, as preventative. In other words, the two points of view should be as follows: First, that of making fire resisting all that can be so treated without the creation of an excessive expense in constructing the central station; second, that of making the proper provision for fire when it does by accident appear, such as fire hose ready for use and a substantial water pressure instantly on tap. In fact, the two intentions must be clearly shown in what deserves to be called a properly designed station. Such as this will readily demonstrate the idea by the use of the best fireproofing and precautionary methods of protection, such as a modern architect and up-to-date consulting engineer would suggest.

The use of adequate water supply and sufficient good hose is essential if a serious idea is entertained of actually preventing the spread of a fire when it does start. No one is so foolish as to deny such possibilities, even in the best equipped of all stations, for evidence has been given of fires in so-called fireproof buildings which showed conclusively that a fierce stubborn blaze is so highly destructive, that even so-called fireproof material is apt to break down under its influence. The fact that oil is used in large transformers, and that even its non-use does not eliminate fire danger from transformer houses, indicates the necessity for precautionary remedial and protective methods in the form of fire walls, non-combustible materials and plenty of water, ready at a moment's notice in sufficient and convenient quantities.

The suggestion entertained by the writers of the National Code, that if possible, transformer houses be built separate from the main building, is in perfect harmony with common sense, utility and a keen sense of the necessity for making provision beforehand for what such a catastrophe may cause. The cutting off of the transformer building from the main building is an essential that cannot logically be neglected, as other than such precautions, when occasion arises with a high tension system, simply means the courting of disaster. All lightning arresters and switches connected to this particular part of the equipment can, under such circumstances, if intelligently installed, be readily disconnected and risks otherwise imminent be entirely eliminated.

The National Code covers features of construction in power houses and central stations in an admirable manner. In fact, it is rather surprising that so many are apt to confess ignorance of rules and regulations that may be found within its pages. Among such forms of advice are those which refer to walls of brick or other equally good fireproof material; to floors of incombustible material; to the generous use of metal lathing and hard plaster away from the neighborhood of high tension wires; to ceilings constructed protectively, of other than wood if possible, or if of wood, fireproof beyond question. Along lines of this character, fireproof stations are best erected. In accordance with principles accepted by capable experts as the most advisable to consider central stations may be built and equipped, but it must be remembered that negligence afterwards may defeat the original purpose and fire which then ensues complete a wholesale destruction. The best rule, therefore, is to always be ready.

Rejections and Penalties for Lamp Manufacturers

The government specifications for carbon filament electric lamps was published in the March issue of THE CENTRAL STATION, and must have attracted the attention of lamp manufacturers all over the United States. The article covers such ground as the following: Matter relative to samples, comparative tests, standard incandescent lamps, general conditions, definitions and standards, method of test, mechanical and physical characteristics, bulbs, bases, filaments, leading-in wires, vacuum, marking, general features, rejection for defects, initial limits, life and candle-power maintenance, values for oval, anchored, plain standard lighting and for round bulb, tubular and other irregular types of lamps, then finally rejections and penalties.

There are a few things to consider in connection with a demand of this kind upon manufacturers, which will probably be intensely interesting to our readers. But before they are able to do so we take the liberty of placing before their eyes once more the few short paragraphs entitled, "Rejections and Penalties." They appear in print in the following illuminative form:

"The failure of the lamps in any package to conform to the specifications as to mechanical and physical characteristics, or to initial limits may cause the rejection of the entire package.

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"The failure of the lamps to give within 90 per cent. of the values of useful life given in the tables may cause the cancelation of the contract.

"Lamps which have not been used and are rejected under the terms of these specifications will be returned to the manufacturer at his expense, and no payment will be made therefor.

"Prompt notice will be served upon the contractor of the test results on lamps that are rejected, or that fail to meet the specified requirements."

The deductions to be naturally drawn from these statements are that the government wants exactly what it asks for, no more, no less. There are a few lamp manufacturers who might ask whether there could be any more to be asked for. On the other hand, there is a possibility that a few might otherwise ask whether no other requirements are demanded. But the point is this, after all is said and done; How many of the increasing horde of lamp consumers take the trouble to formulate a bill of particulars as to what they want of lamp manufacturers? Is it not curious to realize that the average small lamp purchaser differs a little from the purchaser in other departments of trade? How many of them would take the trouble to state emphatically and definitely what they want, and then see that they get it?

At least some lesson can be learned from the terse and highly expressive language used by the government in making its demands upon the lamp manufacturers of America. What better lesson than that of defining the proposition of purchase in unmistakable language? Severe as the requirements seem to be when casually glanced over, the idea that prevails is unquestionably this, summed up in a few words: The government wants good lamps.

The government when purchasing lamps is transacting business just the same as any other corporative body. Its demand for quality is nothing more than anyone else would ask who knows what can be had and intends getting it. Lamp manufacturers reading the specifications for the first time have had an opportunity of judging of the attitude the government holds to those selling it its lamps.

MONTHLY REVIEW OF THE TECHNICAL PRESS

Side-Street Lighting

By A. C. Hanson.

The problem of the lighting of the main thoroughfares is usually solved, except in some of the gas-mad towns, by the adoption of arc lamps; either flame, enclosed or ordinary open type. It must be recognized, however, that arc lamps of any thoroughly satisfactory type form too large units for the lighting of what may be conveniently described as side streets. The lighting of these streets, therefore, is usually effected by gas lamps, either incandescent or "batswing;" though, in a considerable number of towns, electric light in some form or other has been partially adopted.

It will generally be conceded that ordinary carbon filament lamps are not a success for street lighting. The first experiment in electric street lighting (after the main streets had been lighted by arc lamps) in the town of which the electric supply is in my charge, was by the erection of some 10 posts, each carrying two 16-c.p. lamps. These posts replaced "batswing" gas posts, and from a photometric point

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of view, the result was satisfactory, but as the incandescent gas lamps replaced the flat-flame in the neighborhood, complaints were heard of the dull electric light, though on windy nights when most of the gas lamps were blown out, and the remainder were scantily clad with half a mantle, I have no doubt the wind-scorning electric lamps were blessed. There is one form of carbon filament lamps that I think might have been adopted to a greater extent than it has been, and that is the reflector glow lamp, made with a reflecting back of parabolic shape, so designed as to throw a beam of light down the footpath. I have some miles of streets lighted by these lamps, and the lighting both of the footpath and of the roadway is sufficient and uniform. Even here, however, the ubiquitous "man in the street," whose method of judging street illumination is by seeing how completely he is dazzled by looking at the lamps, soon cries for the white-green glare of the incandescent mantle.

In many towns the Nernst lamp has been largely adopted as a rival of the gas lamps for side street lighting, and there are many points in its favor. With a proper globe, either clear or holophane, it is efficient; the light distribution of the A and A.D. types is good, especially with the holophane globe; and the light is white enough to satisfy the popular demands.

En passant, I should say that both the old type of frosted globe, and the more modern opal glass, are great light absorbers, and should never be used. The frosted globe especially, after a few days' exposure to dust and rain, is enough in itself to damn the Nernst lamps. The extreme unreliability of the Nernst burner, is, however, a strong argument against its use for street lighting; one burner will burn, if it is allowed, for 1,000 hours, the next two or three may have an average life of under 100 hours.

In Stirling, where I have about a hundred of this type of lamp in the streets, I have tried replacing all burners after a certain fixed life, say, 600 hours, but the large proportion that give out before this life has been attained reduces the average life to an absurdly low figure; therefore I have gone back to the system of letting each burner live its own life—with a maximum of 1,000 hours—and the results are somewhat better from the point of view of economy. When this system is adopted, however, one has to face the very unpleasant fact that each lamp will be out one night in every few weeks during the dark season; and if two or three adjacent lamps take it into their heads to die on the same night, the lighting of the street on that night will hardly prove a good advertisement for electric street lighting.

The tantalum lamp, the only form of metallic filament lamp freely obtainable as yet in this country, is the one which, to my mind, is best suited for the electric lighting of side streets; the locus of the light is large, the distribution good, the color right, and the efficiency fairly high I find that two 115-volt tantalum lamps taking about .36 ampere give a better lighting effect than a ½-ampere Nernst lamp. By this I do not mean to assert that absolutely more light is obtained from the tantalum than from the Nernst lamp, but that the lighting effect is better. The life of these lamps is also more uniform; only a small proportion expire under 500 hours, in fact, quite as many last over 800 hours.

By fixing the maximum life at, say, 650 hours, one is rarely shocked by the sight of a "dead 'un." One important point—don't over-run tantalum lamps. A network near a feeding point is always carrying more than the declared pressure; in such cases it pays to keep two voltages in lamps, say, 120 and 115, and arrange the lamps according to the real pressure at which they run. It is easy to keep districts separate, and with a little care, no confusion should occur; while the effect in the increase of life is marked, and the effect in decrease of light is not. Assuming that tantalum lamps have been chosen for side-street lighting, the next question is, how are they to be connected to the mains? Undoubtedly the best method is to run a special main for street lighting, and where public lighting goes before the ordinary supply, this method will be adopted as a matter of course. In the majority of towns, however, the streets were fairly well cabled before side street lighting was thought of; and in such cases the extra expense of a separate main might turn the scale in favor of incandescent gas.

It must be remembered that to get the full benefit of separate circuits for street lighting, the system must be carried throughout; little saving in wages, etc., is effected by having a few streets lighted from separate circuit, while the remainder are lighted by lamps connected to the distributor. In most small towns the engineer will not be able to obtain a lamp district at one "fell swoop," he will have to content himself with the conversion of two or three lamps here and two or three lamps there, till finally the whole district is electrically lighted. In such cases one is driven to connect the lamps direct to the ordinary supply, and if the work is done in a proper manner very little trouble will be experienced. A cheap, and, I believe, a usual method is to run lead-

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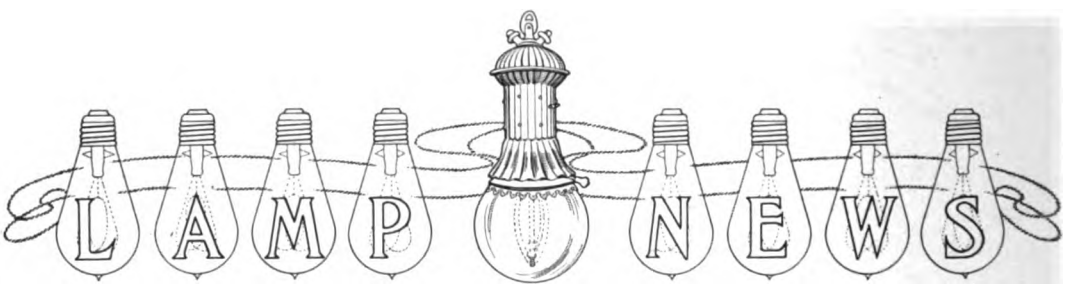
covered rubber wire from the distributor joint box up to the switch and fuse box at the top of the post. If two points are carefully watched, this will make a satisfactory job, although I have now discarded lead-covered wire for this work. The two points are, first, the wires must be properly sealed at the fusebox, and second, the lead covering must be thoroughly protected from mechanical and chemical action on its way from the joint box to the lamp base. The protection of the lead covering may either be given by running the wire solid in wooden troughing, or, as I found to be cheaper, more convenient, and probably as efficient, by drawing the wire into circular loom. It is not easy to get a completely satisfactory seal in the fuse and switch box, as the space is small, few boxes are properly designed, and the extremes of heat and cold are very trying. It is worth while spending time and money on this detail, as the life of the service depends on it. The method I have now adopted is to run two 7-23 specially taped wires in two lengths of circular loom from the joint box to the switch. Up to the present I have had no trouble with any of the services run in this way.

The switch I use is a double-pole switch with a double-pole fuse attached to the switch block, which latter is removable for fuse renewals. It is most important to have a very strong switch, as lamplighters are by no means gentle in their methods. In the earlier forms of switch, it was no uncommon occurrence for the switch handle to be twisted off the spindle. The insulation of the switch and fuse should be of the best, as the apparatus is exposed to all the samples of weather for which this island is famous.

A small detail which is apt to be overlooked is that of the advisability of having an insulator between the lamp-holder and the switch box. A breakdown of the insulation of a lamp-holder is not infrequent, and should not be allowed to earth the post. If an insulating nipple is placed between the lamp-holders and the extension piece from the switch, an earthed lamp-holder is of small importance.

The question of costs does not come within the scope of these notes, and I can only say that I can compete with equivalent gas lighting on this point, and give in addition the advantages inseparable from electric lighting.

—*London Electrical Review.*



Tungsten Lamps for Standard Lighting Service

The production of filaments of rare metals has effected a material advance in lamp efficiencies, and has culminated in the greatest achievement in the art of lamp manufacture—the Tungsten lamp.

This lamp gives a good commercial life at the remarkable efficiency of from 1 to 1¼ watts per candle, or practically three times the light given by ordinary carbon incandescent lamps for the same power consumed. This striking result, surpassing all previous discoveries and developments in electric incandescent lamps, has become possible through the production of a filament of the rare metal Tungsten, a particularly suitable material for filaments by reason of its very high fusing point—about 3050° C.

The General Electric Company has developed special processes for the production of filaments of Tungsten and are now producing Tungsten lamps of excellent quality and satisfactory life in the various sizes listed herein.

The Tungsten lamp gives a light of high brilliancy and of agreeable color and quality, closely resembling daylight. The low resistance of Tungsten necessitates a considerable length of filament

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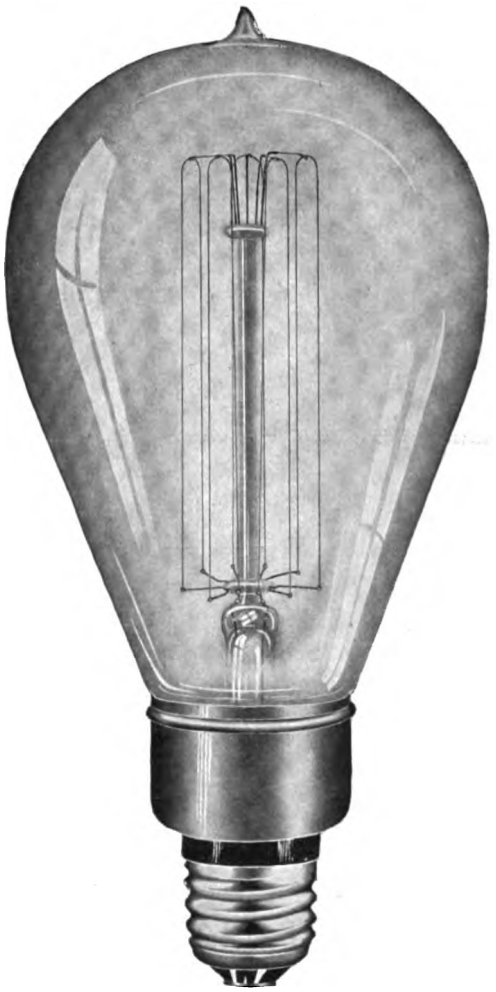
for a 100-120 volt lamp. The filament is made up of four or five hairpin loops connected in series, as shown in accompanying illustration.



(Illustration ⅔ actual size.)

REGULAR TUNGSTEN LAMP—100 TO 125 VOLTS—100 WATT—80 C.P. (MEAN HORIZONTAL).

Tungsten, in common with other metals, has a positive temperature co-efficient, *i. e.*, its resistance increases with increase of temperature, so that the change of current in the lamp is not proportional to the change in voltage, as it is in the carbon lamp, but is more independent of changes in voltage. This means that the Tungsten lamp undergoes smaller changes in candle-power, efficiency and life with change in line voltage than in the case of the present carbon lamp. This feature gives the Tungsten lamp valuable advantages inasmuch as the effects of bad regulation such as light fluctuation and reduction of lamp life, all of which have an important bearing on the copper required for feeders, are materially diminished.

The Tungsten lamp is serviceable on both alternating and direct current, and gives equal life—approximating 800 hours—on both. Tests conducted show a remarkably slow and small decline in candle-power during life, so small that well-made lamps can be satisfactorily used until they burn out.

The filaments of Tungsten are naturally more delicate than those of carbon but this difficulty is overcome by special packing methods and by the exercise of greater care in handling the lamps. The lamps are individually wrapped in batting and enclosed in pasteboard cartons on which are printed instructions as to how the lamps should be handled. In this way the Tungsten lamp can be transported safely and employed satisfactorily.

As the Tungsten lamp gives its best results when

(Illustration ⅔ actual size.)

TUNGSTEN LAMP—40 WATTS—32 C.P.—100 TO 125 VOLTS.

used in a vertical pendant position it can be employed to excellent advantage in a unit combinaiton with suitably designed Holophanes after the manner of the GEM Units. The lamp is supplied at

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present in three sizes for regular multiple service, consuming 40, 60 and 100 watts.

These lamps fit in the regular Holophanes designed for the present GEM lamps, giving candle-power values as shown in the curves of candle-power distribution on this page.

lighting rates in force, is worth several times the cost of the lamp.

The actual saving is 2.25 watts for every candle of light, giving a saving of 2.25 kilowatts for every 1,000 candle hours. This means a saving on a 32-c.p. lamp of $7.20 to a consumer paying a 10-

Form B—Holophane.

Form C—Holophane.

GE TUNGSTEN INCANDESCENT UNITS.

The 40 and 60 watt lamps employ No. 2 Holophanes and the 100 watt lamp the No. 3 Holophanes.

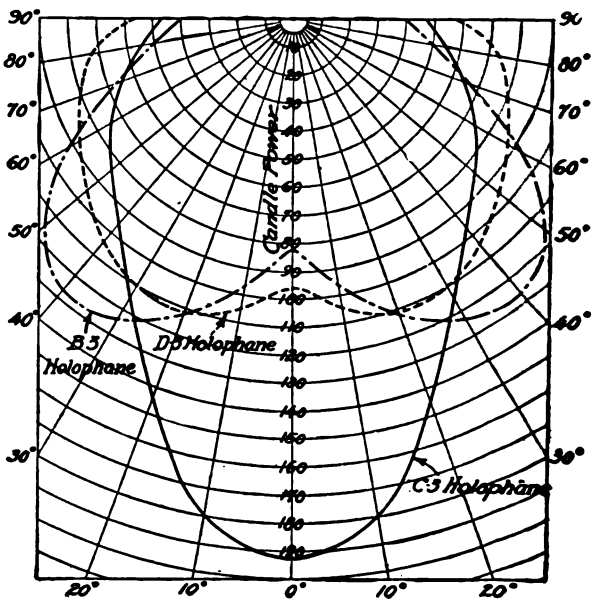
This interchangeable feature should greatly increase the value of the Incandescent Units as the Tungsten lamps are adapted to the same shades and fixtures, doubling the candle-power values by simply substituting the new lamps for the old in the ordinary course of renewals.

The form B Holophane is the most desirable reflector for general use with the Tungsten lamp. With sand blasted inside the B Holophane gives a soft and very agreeable lighting effect.

The Tungsten lamp like the GEM is rated in total watts. Each lamp is read at an exact efficiency (in standard watts per mean horizontal candle) for voltage. Each lamp is therefore burning at a uniform degree of incandescence and while the actual candle-power and total watts of the lamp may vary from the average rating, lamps will appear of uniform brilliancy and be subjected to uniform temperature strain. This method of rating therefore insures the maximum of well and uniformly maintained candle-power and life.

The price of the Tungsten lamp, due to the difficulty and cost of its manufacture, is somewhat higher than ordinary lamps, but is far less than its value to the consumer. Compared to the carbon filament lamp of equal life (the 3.5 w.p.c. lamp), the Tungsten lamp saves practically two-thirds of the cost of current, and this saving, at the average cent rate. With such figures as these no extended tables are required to show that the Tungsten lamp is worth all it costs to a consumer.

To the central station the Tungsten lamp is of value in reducing the cost of lighting and in giving



C.P. DISTRIBUTION CURVES OF 100 WATT GE TUNGSTEN INCANDESCENT UNITS WITH B-3, C-3 AND D-3 HOLOPHANES.

The values for the 40 watt lamp are 4/10, and for the 60 watt lamp 6/10 of the value given by the above curves for the 100 watt lamp.

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three times the light for the same current cost, thereby assisting to meet competition and promote the use of electric light. No such opportunity for promoting lighting business has ever been given before by any other lamp.

The Tungsten lamp can be used to advantage in reducing the maximum demand and thus releasing an equivalent capacity of station and distribution system for sale to other customers. At the same time, through the increased hours of use induced by the high economy of the Tungsten lamp, the consumption of customers may be maintained as before or even increased.

Variation of Candle Power of Metallic Filament Lamps with Voltage

The results of tests made on Nernst, carbon, tantalum, osmium, and tungsten lamps are given in an article by F. Hirschauer in a recent number of the *Elektrotechnische Zeitschrift.* It is shown that the candle-power varies as the tenth power of the voltage in the case of the eNrnst lamp, as the 6.3 power with the carbon lamp, the 4.3 power with the tanalum lamp, and the fourth power with the osram and tungsten lamps. It would seem therefore that the new metallic filament lamps are not only of much higher efficiency than the older types, but that they have a further decided advantage in being less susceptible to the changes in terminal voltage which always occur more or less on public supply networks.

Helion Lamp Patents

A description of the Helion incandescent lamp, in which the inventors gave full particulars of its development and test results, appeared in *The Electrical Magazine* of February last year. Three American patents were recently issued to W. G. Clark on processes for making the incandescent lamp filaments which consist of a combination of silicon and carbon. The deposits of silicon have been obtained by the decomposition of chlorides, and the object of the patent is to obviate the difficulty that has been experienced in getting a uniform product and to prevent the chlorine once free from combining with the silicon. The first of the several patents describes a process wherein a carbon filament is placed into a receiver containing a small quantity of mercury, after which a silicon chloride, such as a tetra-chloride and also a gas which contains carbon, are introduced. When the current is passed through the filament the chloride is decomposed and the silicon deposited upon the carbon, and the free chloride combines with the mercury. The second patent covers the use of the carbon gas referred to above, the claims being for the mixture of marsh gas and an olefiant gas, or marsh gas, olefiant gas and carbon dioxide. The third patent states that the hydrocarbon gas may be some form of illuminating gas, but is preferably the marsh gas. When the decomposition on the filament takes place the silicon and combination of silicon and carbon, which is a dense, non-porous combination, enter the pores of the carbon base, combine with and build up on the base, so that the latter becomes a combination of silicon and carbon, which gradually merges near the surface into a substance having characteristics similar to those of silicon.

The Western Electric Company reports that the demand for Sunbeam Tungsten and Sunbeam Tantalum lamps is something enormous; in fact, the orders for Tungsten lamps are pouring in more rapidly than they can be filled. The Sunbeam people are increasing their production of Tungsten lamps daily, but the demand is keeping pace with the output. A new factory will be started in May, which will be devoted exclusively to the manufacture of Tungsten lamps and, without doubt, the situation will be bettered accordingly.

Judging from the way the orders are coming in, the lamp consuming public is fast awakening to the fact that the use of carbon filament lamps is an extravagant and useless waste. The day of the coal eating carbon filament lamp is past. It will soon be relegated to the background and classed with spinning wheels and hoop skirts. The fact that the light given by the Tungsten lamp is the same as sunlight, has induced many dry goods stores, clothing merchants, etc., to install same as colors are shown up in their true values. The ordinary central station customer, however, is demanding these lamps on account of the fact that they consume only one-third as much current as a carbon filament lamp. Central stations are finding Tungsten lamps to be a desirable weapon with which to combat the growth and installation of gasoline and gas arcs.

The Sunbeam Tungsten lamp is being manufactured at present in 40, 60 and 100 watts at an efficiency of 1¼ watts per c.p. A request either to the Western Electric Company, the general dis-

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tributing agent, or the Sunbeam Incandescent Lamp Company, Chicago or New York, the manufacturers, will obtain a bulletin giving full information, such as comparative curves, prices, etc

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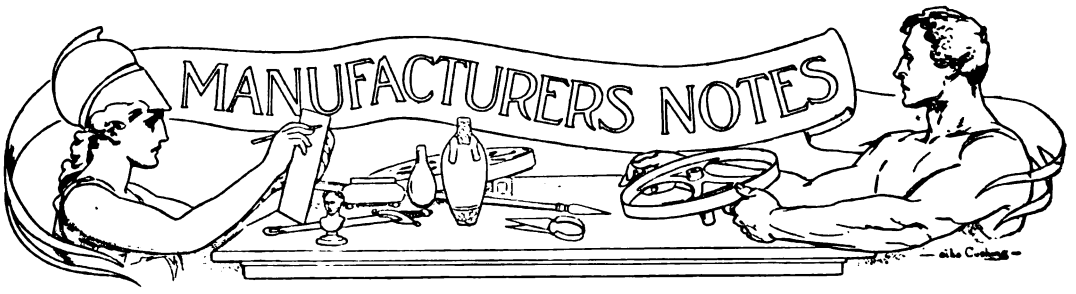
The Elblight Company, of 36 E. 23rd street, New York City, electrical decorators and owners of the Elblight system for electrical decoration, have recently compiled a dozen or more large albums containing views of their installations of "Elblight" lamps and cables for decorative purposes. These are intended to be loaned to central stations which are contemplating electrical decoration for any functions or occasions taking place in their cities or towns. These albums show a variety of decorations for both the exterior and interior of buildings, and the illumination of parks, etc.

They form a most practical guide for any class of decoration desired.

Mr. Charles J. Purdy, treasurer of the American Electric Lamp Company, of New York, has just returned from a trip to Boston, where he secured the enormous contract for lamps for the Boston Elevated Railroad Company. This means not only for the elevated, but for the Subway and surface lines of the city of Boston as well, and is a great victory for "American" lamps.



Hartford Time Switches.

The two new types of the Hartford automatic time switches just placed on the market by the Hartford Time Switch Company, 97 Warren Street, New York City, are claimed to be the greatest advance made in automatic time switches in recent years; that with this line of switches added to their already large line, the field for automatic time switches is fully covered by their product, and that they can now supply automatic time switches with a capacity up to 300 amps. and in voltage up to 2,500.

The automatic time switches made by this company up to 50 amperes capacity have been out many years and are too well known to need describing, but a description of their new types—"H-5" and "L-5"—will be of interest to both central station managers and contractors.

Type "L-5" is made from 75 amperes to 300 amperes, 250 volts, in single, double and triple pole, and is a combination of the Hartford time switch and a standard knife switch operated by a pair of solenoids, one for opening and one for closing the circuit. These solenoids are operated by means of the time switch and the design and arrangement is very carefully worked out, especially that part relating to the operation of the solenoids. The operation is as follows: When the time is reached when the main circuit is to be closed, the operating switch is automatically thrown in contact by the time switch which energizes the closing solenoid and the closing of the main switch itself automatically cuts out the solenoid after its work is done. It is all performed with great rapidity and the solenoid is only in circuit for the fractional part of a second.

The operation of opening the main circuit is similar to the closing, the opening break is practically instantaneous, and the same automatic cutting out of the operating solenoid takes place.

The safety of the solenoids is carefully guarded, and there is absolutely no possibility of their being burned out or injured, and, if for any reason, the safety factors already mentioned as guarding the solenoids should fail to work a final safeguard is provided in a fuse that blows out before either solenoid could be injured.

The whole switch is of extreme simplicity and is entirely self-contained. In installing it is only nec-

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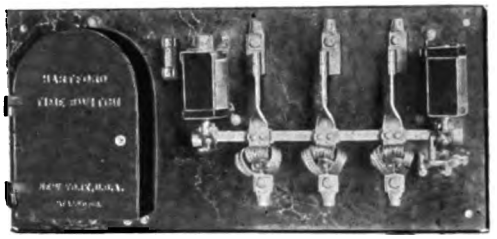
essary to connect the line with the switch in the usual manner, and set and wind the time switch, as all the wiring for the operation of the solenoids is mounted with the switch.

Type "H-5" for high potential circuits operates much as the type "L-5" switch, excepting that the break of the main switch takes place in the oil chamber. In this switch the handling of the high



TYPE "L-S" SINGLE, DOUBLE OR TRIPLE POLE.

voltage current is covered with every safeguard to prevent leaking or short circuiting. All leads are through porcelain and glass to the oil chamber and the switch proper is constructed with greater solidity and with a large excess of carrying capacity in the blades and contacts. In operating the solenoids in this type, when no independent secondary low voltage current can be used, a small transformer is furnished, mounted on the same board with the

TYPE "H-S" FOR HIGH POTENTIAL CIRCUITS.

switch, for use on the solenoids only. As before mentioned, the current is drawn on for the solenoid operation for only an instant and the same safeguards mentioned in the type "H-5" switch are used.

While it is not in the scope of this article to go into the waste of energy, core loss and deterioration always attendant upon high potential transformers, central station managers will doubtless find many cases where much of these losses can be reduced, or entirely eliminated, by the use, especially in outlying sections and in sub-stations, of these switches.

The Hartford Time Switch Company will be glad to answer any inquiries regarding these switches and the uses to which they can be put, and they make the statement that they are now able to furnish an automatic time switch to meet almost any condition in the commercial use of electricity for light and power.

H. B. Kirkland Company, 253 Broadway, New York City, is the name of the new firm with Harry B. Kirkland as president, and Charles F. Boynton as treasurer.

This new firm will act as selling agent for the National Metal Molding Company, of Pittsburg, and will handle the well-known flexible conduit known as "Flexduct," and the rigid conduit known as "Economy," manufactured by the latter company.

There is not a better known or more popular combination in the electrical field than Harry Kirkland and Charlie Boynton; and the host of friends which these two young fellow have made in the electrical field, combined with their ability to "deliver the goods," is an asset to be envied by many an older organization, and assures the success of this happy combination from the start.

D. Van Nostrand Co., publishers of scientific books, 23 Murray street, New York City, are being kept busy these days filling their constantly increasing orders for the new Fifth Edition of Foster's "Electrical Engineers' Pocket Book." This new edition is certainly the most complete reference book ever published, consisting as it does, of 1,100 pages, with almost an equal number of illustrations and diagrams, embodying the very latest practice in electrical construction and experiment. The book abounds with tables and formulæ of the most practical kind, and the use of higher mathematics is not resorted to, which makes this book as valuable to the practical central station man as to the student in electrical engineering. If there is to be only one reference book in the electrical department of any central station, it should be Foster's "Electrical Engineer's Pocket Book." It covers absolutely the entire field.

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PROGRAM

of the

NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION

Chicago, May 19-22

TUESDAY, MAY NINETEENTH.

OPENING SESSION, TEN O'CLOCK.

President's Address.

Announcements, by the Secretary.

Report of Committee on Progress, Mr. T. Commerford Martin, New York.

Distribution in Suburban Districts, Mr. George H. Lukes, Chicago, Ill.

Tape, Mr. Paul Lüpke, Trenton, N. J.

Report of Committee on Grounding Secondaries, Mr. W. H. Blood, Jr., Chairman, Boston, Mass.

Series Incandescent Lighting with Tungsten Lamps, Mr. P. D. Wagoner, Schenectady, N. Y.

AFTERNOON SESSION, TWO-THIRTY O'CLOCK.

Observations on the Precision of Different Types of Photometer, Professor A. E. Kennelly and Mr. S. E. Whiting, Harvard University.

Power Load Development for Central Stations of Moderate Size: Some Unappreciated Possibilities, Mr. Chas. Robbins and Mr. J. R. Bibbins, Pittsburgh, Pa.

The Small Station and Its Economical Operation, Mr. J. T. Whittlesey, Newark, N. J.; Mr. Paul Spencer, Philadelphia, Pa.

Question Box, Mr. Alex. J. Campbell, Editor, New London, Conn.

Report of Committee on Uniform Accounting, Mr. H. M. Edwards, Chairman, New York City.

Candle-Power Standard—The presentation of resolutions toward the adoption of an international standard.

WEDNESDAY, MAY TWENTIETH.

MORNING SESSION, TEN O'CLOCK.

General Meeting.

Report of Committee on Gas Engines, Mr. W. C. L. Eglin, Chairman, Philadelphia, Pa.

Low-Pressure Steam Turbines, Mr. John W. Kirkland, Schenectady, N. Y.

Report of Committee on Meters, Mr. L. A. Ferguson, Chairman, Chicago, Ill.

Receiving Stations Operated from High-Tension Lines, Mr. S. Q. Hayes, Pittsburgh, Pa.

Report of Committee on Organization Possibilities, Mr. Henry L. Doherty, New York City.

Special Meeting, Banquet Hall, Sixth Floor.

PARALLEL SESSION, TEN-FIFTEEN O'CLOCK.

Uniform Accounting and Its Details—Open to all accountants and others interested. Mr. H. M. Edwards, Chairman Committee on Uniform Accounting, will preside.

EVENING SESSION, EIGHT O'CLOCK.

Executive Session.

Report of Secretary and Treasurer and Executive Committee.

Report of Insurance Expert, Mr. W. H. Blood, Jr., Boston, Mass.

Report of Committee on Public Policy, Mr. Arthur Williams, Chairman, New York City.

The Status and Commercial Possibilities of High-Efficiency Lamps, and Discussion, Mr. W. W. Freeman, Brooklyn, N. Y.

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Report of Committee on Rates and Costs, Mr. R. S. Hale, Chairman, Boston, Mass.
Election of Nominating Committee.

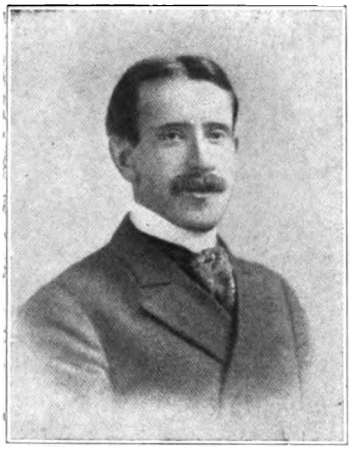
THURSDAY, MAY TWENTY-FIRST.

MORNING SESSION, TEN O'CLOCK—AFTERNOON SESSION, TWO-THIRTY O'CLOCK.

COMMERCIAL DAY.

Mr. C. W. Lee, Chairman Programme Committee, New York City.

Mr. Henry L. Doherty, Past President, will preside during Commercial Day Sessions.



DUDLEY FARRAND,
President.

GEO. F. PORTER,
Master of Transportation.

W. C. L. EGLIN,
Vice-President.

OFFICERS OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

1. *Address*—Relationship Between the Engineering and Commercial Departments, Mr. Louis A. Ferguson, Past President, Chicago, Ill.

2. *Preparation for a Campaign:*
   (a) Field Work and Other Essentials.
   (b) Analysis of Customers' Accounts.
   (c) Proportion of Lamp Equivalent Lost to Lamps Connected—Showing Percentage in Cities of Varied Population.
   (d) Policy of Handling Complaints.
   (e) Policy of Handling Collections.
   Editor: Mr. H. J. Gille, Minneapolis, Minn.

3. *The Contract Agent and the Representative:*
   (a) The Contract Agent—His Possibilities.
   (b) The District Representative—His Possibilities.
   (c) The Special Representative.
      1—The Sign Expert.
      2—The Power Expert.
      3—The Woman Representative.
   (d) Solicitors' Meetings—Their Objects.
   Editor: Mr. V. A. Henderson, Memphis, Tenn.

4. *The Display-Room:*
   (a) Appointments and Methods.
   (b) Value of Special Demonstrations.
   (c) Value of Electrical and Food-Show Exhibits.
   Editor: Mr. L. G. Mathes, Dubuque, Iowa.

5. *Advertising:*
   (a) What is Being Done.
   (b) Why?
   (c) Results.
   Editor: Mr. Charles A. Parker, Detroit, Mich.

6. *Publicity:*
   (a) Methods to Create Proper Public Sentiment.
   (b) Dormant Publicity Opportunities of Lighting Companies.
   Editor: Mr. Percy Ingalls, Newark, N. J.

7. *Creating Demand for Electricity:*
   (a) The Creative Principle.
   (b) Notable Examples.
   (c) Stereopticon Talk Upon Outline and Sign Lighting—Showing Progress in Large and Small Cities.
   Editor: Mr. Frank B. Rae, Jr., New York City.

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8. *Evolution of New-Business Building:*

   (a) Examples of Central Stations That Have Continued Methods During Depression.
   (b) Strong Plea for Upkeep of Commercial Departments and Advertising.
   (c) Opportunities for Creating Business Along Existing Lines.
   Editor: Mr. George N. Tidd, Scranton, Pa.

9. *The Electrical Contractor:*

   Symposium:
   (a) What He Is Doing to Assist in Creating Greater Demands for Electricity.
   (b) Specific Examples.
   Editor: Mr. Joseph F. Becker, Jr., Brooklyn, N. Y.

10. Co-operative Commercialism, Mr. J. Robert Crouse, Cleveland, Ohio.

11. Illuminating Engineering as a Commercial Factor—Illustrated. Mr. V. R. Lansingh, New York City.

12. Report of Committee on Solicitors' Handbook Prize Award, Mr. John F. Gilchrist, Chairman, Chicago, Ill.

13. Report of Committee on Co-operative Electrical Development, Mr. W. W. Freeman, Chairman, Brooklyn, N. Y.

FRIDAY, MAY TWENTY-SECOND.

MORNING SESSION, TEN O'CLOCK.

General Meeting.

Illuminating Engineering, Mr. W. D'A. Ryan, West Lynn, Mass.
Report of Committee on Protection from Lightning and Other Static Disturbances, Mr. R. S. Stewart, Chairman, Detroit, Mich.
The Value of Care and Maintenance of Meters, Mr. H. D. King, Hoboken, N. J.
Some Experiments in Combustion, Mr. S. J. Lenher, New York.
Specifications for Construction on Joint Poles, Mr. Paul Spencer, Philadelphia, Pa.
Final Report of 1907 Committee to Consider Specifications for Street Lighting, Mr. W. D'A. Ryan, West Lynn, Mass.
Memorials, Mr. T. C. Martin, New York.
Executive Session.
Report of Nominating Committee.
Election of Officers for the Ensuing Year.
Adjournment.

Special Meeting, Banquet Hall—Sixth Floor.

PARALLEL SESSION, TEN-FIFTEEN O'CLOCK.

COMMERCIAL DAY.

Unfinished Business (if any) from the Thursday Session.

BADGE COLORS FOR THE 1908 CONVENTION.

Name of Committee	*Color of Badge*
Honorary	White
Officers	Red
Member Companies	Class A, Purple
Members	Class B, Rose
Associate Member Companies	Class D, Golden Brown
Associate Members	Class E, Pink
Guest	Pale Blue
Press	Dark Brown
Executive Committee	Dark Blue
Reception Committee	Red, White and Blue
Entertainment Committee	Red, White and Blue
Hotel Committee	Yellow
Exhibition Committee (Same as Class B)	Rose

HEADQUARTERS LOCATIONS.

Secretary's Office—Parlor floor Auditorium Hotel.
Registration and Post-Office—Parlor floor Auditorium Hotel.
Entertainment Committee: Bureau of Information—Parlor floor, Auditorium Hotel.
   Information regarding Chicago or the convention may be obtained here, and tickets for the various entertainment features will be distributed from this Bureau.
Exhibition Committee: Exhibition Hall—Ninth floor, Auditorium Hotel.
General Meetings: Assembly Hall—Adjoining Exhibition Hall.
Special Meetings: Banquet Hall—Sixth floor, Auditorium Hotel.

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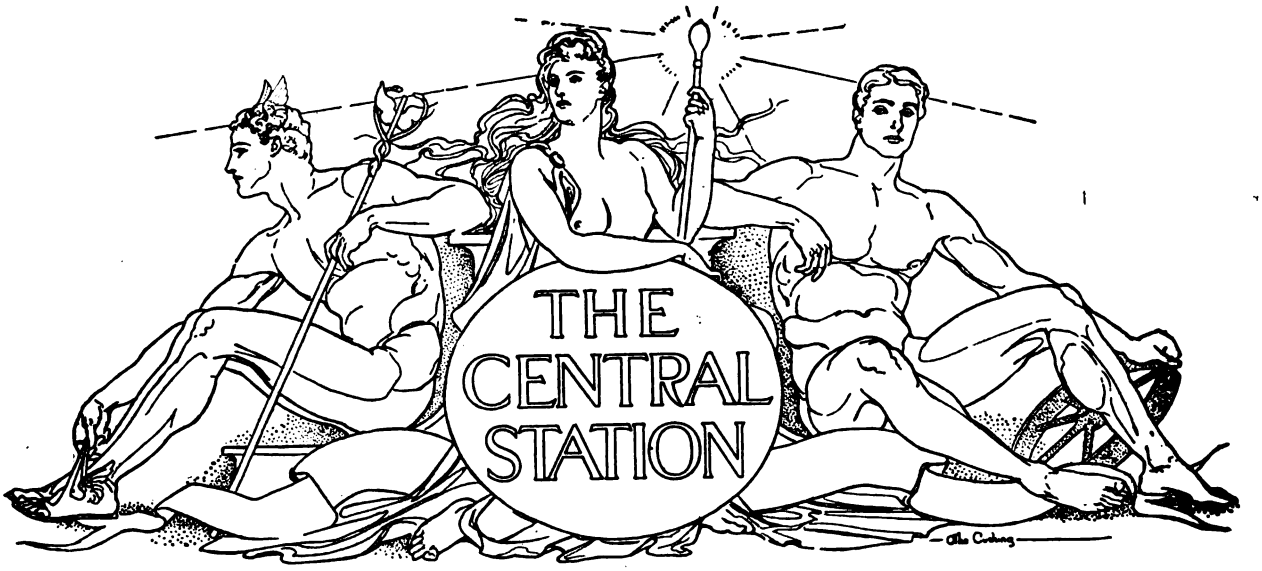

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS.

VOL. 7, NO. 12. NEW YORK, JUNE, 1908. ISSUED MONTHLY.

Central Station Light, Heat, and Power Principles

BY NEWTON HARRISON.

Carbon at High Temperature.—The condition of carbon at a very high temperature is such as to make it an interesting proposition to consider, with respect to its use as an incandescent filament for a lamp. The original idea of Edison that a lamp filament must be made of a grained, fibrous material, was completely negatived by the introduction and use of cellulose. The fact that carbon displays peculiar phenomena when at a very high temperature, does not mean that these manifestations are very different from those of other substances under the same conditions. For instance, carbon may be so heated that it will actually boil, and naturally give off the fumes or vapor of volatilization. The filaments employed in ordinary lamp service are subjected to an intense heat, and to some degree undergo this process; namely that of shedding their outer surface in the form of fine particles of carbon which coat the interior of the globe and make it appear dull yellow or brown.

The remedy for this difficulty suggested by the conditions, was that of providing carbon of such a character that its outer surface was not affected to the same degree at the same temperature as if it were in its ordinary form. That which is called metallizing the filaments has thus arisen, due to the need of preparing carbon in filament form, to meet a higher temperature or the same temperature with a greater degree of durability.

Metallizing the Filament.—To metallize a filament simply means to melt a carbon by exposing it to the enormously high temperature of an electric furnace. To a certain degree, the carbon is actually made to melt, and the outer surface becomes almost diamond-like in hardness, and appears, as the title indicates, to be metallized. Now the only change that can occur in carbon under the influence of high temperature is to some degree that which occurs in the diamond. It tends to acquire a strength and physical resistance which are the natural results of the temperature to which it is exposed. The theory that the diamond is the product of carbon gas at a very high pressure heated to a sun-like temperature, is more or less borne out by the celebrated experiments of Professor Moisson. This savant surrounded iron in an electric furnace with sufficient coke or carbon to make sure of its absorbing some. When the molten iron was impregnated as far as possible with the carbon gas, it was suddenly plunged into cold water. These are the conditions, presumably, which gave rise to the diamond. The proof exists in the finding of very minute diamonds in the iron mass after it was cooled and dissolved with acid.

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It is very likely that carbon exposed to the temperature of an electric furnace becomes, in a sense, glassy, hard and, as already stated, much more resistant to the influence of the temperature arising from the current passing through it than before. Metallizing in this sense means the creation of a physical change in the quality of the carbon, though no noticeable chemical change can or would occur under the circumstances. A filament thus treated is able to reach a higher temperature unaffected and, therefore, yield light at a higher efficiency than heretofore when a current of electricity passes through it. The watt consumption of 3.1 in the older type of carbon filament and its reduction to only 2.5 watts per candle-power in the metallized type, provide an object-lesson leaving little more to be said.

The Use of Metals.—In the manufacture of a filament for an incandescent lamp, history has repeated itself to such an extent that whereas the first incandescent lamp was made by Edison with a platinum filament, the last to date, so to speak, has been made with a Tungsten filament. It is evident that the failure of platinum to comply with the conditions required of it meant its elimination from the field, simply because it was commercially incompetent to serve the purpose intended for it. On the other hand, that which has taken its place as a metal is the result of a series of developments in the use of experimental material which represents the final goal in quality and efficiency. Not only are Tungsten and Tantalum of service as types of advanced lamps, but they represent the result or culmination of twenty years of experimentation directed to the purpose of producing an efficient, long-lived lamp.

It cannot be believed that the use of rare metals or even common metals could possibly have advanced the art, if it were not for an equally great advance in the application of chemistry. For instance, osmium is a rather rare metal, having many of the qualities and characteristics of platinum, which was employed for the making of lamps whose efficiency represented 1½ watts per candle-power. Though this reduction in current consumption meant an advantage such that twice the power was used in the carbon lamp as an osmium lamp, other difficulties beset the path of the experimenter, technically as well as commercially. In considering the question, therefore, of the use of metals for filament construction the following items must be reviewed:

1. The amount of metal obtainable at accessible points of the earth.

2. The cost of the metal when refined and ready for use.

3. The temperature which it will stand when in service.

4. The degree to which the metal can be drawn out, or in other words, its native ductility.

5. Its absolute point of fusion under the influence of heat.

6. The brittleness of the metal when drawn out in filament form for lamp service.

7. The hours of service derived from the metal when in filament form.

8. The general expense connected with the treatment of the metal and its final form in the lamp.

These items are merely a few of the most important which may be enumerated with respect to any given metal serviceable for electric lighting in the manner described. The fact that osmium must be squirted in somewhat the same manner as when carbon filaments are made from cellulose, imposes no insurmountable difficulties. The metal which will stand the highest temperature, proved to be the most durable when mounted, and naturally have the highest efficiency in watts per candle-power, will be the most successful of all that are chosen and tested in the markets of the world.

The Useful Life of a Lamp.—In speaking of the useful life of a lamp, it is generally understood, that reference is not made to the total number of hours of service, but to something a little different. For instance, the useful life of the ordinary incandescent lamp is the time which it takes for the candle-power to diminish twenty per cent. As a general rule, this time varies from five hundred to six hundred hours. On the other hand, it may be understood that the limiting period, according to this rule, may be greater or less. Whatever it may be, it is believed that about five hundred hours covers the fact sufficiently well to be accepted as an average record.

Metals of High Fusibility.—The central station expert is naturally interested in all investigations whose direction tends to open up new fields of lighting. But among the problems which confront him are those of a purely commercial character, such as cost of power per unit of light, and cost of light per annum. The private consumer is interested in the problem of domestic economy to an extent which makes every extra dollar spent unnecessarily a matter of moment. Other things being equal, the conditions which call for the least investment and give the greatest return in light, are naturally those

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which are accepted with the least hesitation. Since the metallic filament lamp has come to the front, the amount of light produced from a given consumption of power has been satisfactorily proven to be far in excess of what it was formerly. The idea gaining ground now, in the public mind, is that the electrical expert is going to produce a lamp costing a nominal sum, consuming a minimum of power and supplying a maximum of light.

The whole question seems to depend upon the lamp inventor and no one else. The problem confronting him is that of obtaining an even less fusible metal than that now in use in osmium, tantalum and tungsten lamps. It may be remembered that there was a time when the manufacturer of the carbon filament lamp believed that the limit of invention had been reached in his case, and the lamp business had settled down to what it would be for years to come, or until a most radical change occurred. The fact that carbon could be metallized was not known, nor would it have been accepted, until proven indisputably, for the reason that various experimental types of lamps were engaged in the competitive struggle for success. The backers of these lamps believed in their commercial future; but time proved that they were all very slight variations of one common type, which was ultimately sold under a variety of names.

The use by Nernst of a rare oxide paved the way for an advance in lamp construction in the sense, at least, that it showed the possibilities lying latent in rare oxides as the filament for incandescent lamps. The metals came into consideration later on, after osmium and tantalum had played their part and been accepted as commercial successes. The Tungsten which is now employed, is a comparatively cheap and common metal and while it presents certain difficulties in its application to incandescent lamp construction, it is not likely that they will prevent its rapid adoption as a successful solution of the problem of economical lighting.

To secure a metal whose fusing point is higher than that of osmium, tungsten and tantalum, is now regarded as the next difficulty presenting itself. Whether this metal will be cheap or dear cannot be anticipated, for the simple reason that the fusing point of metals is in no way proportional to their expense. In other words, the metal which may be employed for lamp filaments might be very rare and consequently correspondingly expensive, and thus the door would be actually shut in our faces, just as we saw success in sight. The whole problem revolves around the question of fusibility at a higher point than has been reached in lamp construction. The four-watt lamp has been cut down to 3.5; the 3.5 watt lamp has been cut down to 3.1 watts; the 3.1 lamp has been reduced to 2.5 watts; the 2.5 watts have been reduced to 2; the 2 of the tantalum lamp has been cut down to the 1.5 of the osmium lamp; and now, to complete the triumph, the 1.5 watt osmium lamp has ben reduced to 1.25 or less in the tungsten lamp. Every step has been fought with redoubtable courage, and the gains made towards the end were rapid indeed. It may be mentioned, in connection with this subject, that carbon can be heated sufficiently to yield more than one candle-power for every 2.5 watts consumed; but as has been stated, the carbon undergoes an evaporative process and deteriorates rapidly at a higher temperature. It is within the range of possibilities that carbon may, in the future, be so utilized, that it will give more light for less power; but that is entirely problematic, and it can only be done, if at all, by the adoption of something other than a filament for light production.

Temperature and Illumination.—The relationship existing between temperature and illumination is such that more temperature generally means a vastly greater illumination, as conversely, less temperature means an uneconomical consumption of power. This is verified very readily in the use of incandescent filaments for electric lighting, and the demonstration of the fact that a little more temperature will give an immensely greater light is made by the use of low pressure carbon lamps on circuits which make them run above candle-power. An ordinary 16-candle-power carbon filament lamp can readily produce 50 or 75 candle-power, if its filament is sufficiently heated by an excess of current. There is no use asking the question why this is not done, because the answer would naturally be that the experiment means the rapid destruction of the lamp.

So far, higher temperatures have been successfully reached and commercially utilized by means of refractory materials, such as osmium, tungsten, tantalum, etc., but though a steady gain has been made in the way of watt consumption per candle-power, the final gain, when the still more infusible element is found and utilized, will be very much greater. The hope existing in the minds of many experimenters, was that they might be able to utilize some disseminated form of matter and expose it to the passage of the current. The fact that even the tungsten lamp is using a great deal of energy in comparison with the light that it gives, has led many scientists to believe that the entire system of elec-

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tric lighting by incandescent filament would fall into abeyance in the next twenty or thirty years.

The high temperature for the production of light is only necessary at present because of the fact that it is only by such means as this that sufficient luminescence is obtained from a given consumption of energy. At the best, light produced from heat is not economical, and there are strong probabilities that the method will be discontinued when some new principles in the manufacture of commercial light have been discovered. It is well known that radiant energy does not call for any large quantity of power to produce it. It is also well known that the 40 or 50 watts consumed in the incandescent lamp ought to be sufficient to produce five or ten times the illumination we now obtain. While there is little doubt that success of a remarkable character will ultimately be reached in the way of obtaining much more light from little energy, by the use of more infusible metals than those now employed, it must be realized that when this end is attained, the new road to travel will diverge abruptly from the old, and lead to untrodden regions in the world of science.

The conclusion regarding the modern incandescent lamp necessarily involves other conclusions which form part and parcel of the same general proposition. Not only must the lamp, to develop to its ultimate objective point of maximum efficiency for minimum power consumption, solve the scientific problem, but it must meet the ever changing conditions of the commercial problem as well. Though little need be feared on either score, the chances, as already outlined that radical departures are inevitable, still hold true as the future, in all probability will prove.

Prepared for THE CENTRAL STATION by Colin P. Campbell, Attorney.

Injuries to Servant - Duty of Master to Warn Servant—Knowledge of Servant

The court said:

The plaintiff has no ground of exception to the ruling made at the trial. By Rev. Laws, c. 106 §§ 71, 73, 74, under which this action is brought, recovery is denied unless the death of the employee is caused either by the negligence of the employer, or of a person for whose negligence the employer is responsible. If the record is somewhat voluminous, the essential features relating to this question are easily distinguishable. The electric wires of the defendant's system having been dangerous for want of proper insulation, new wires were to be substituted, and a gang of men, including the decedent, who was an experienced lineman, were sent out to perform the work, under the direction of a general foreman of the company. The old wires when in position rested on cross-arms of six pins each, equally divided by the pole. Of these wires, the second in each group were used to carry a current of electricity of sufficient voltage to operate motors, while those remaining, consisting of two on each side nearest the pole, and two at each end of the cross-arm, respectively designated as the "pole pin" and "end pin wires," were used to supply electricity for running the lights. If the current in the motor wires was not dangerous to life, each of the lighting wires were charged with an alternating current, sufficiently high to cause the death of those who might come into contact with them. The pole and end pin wires on the street side were left uncharged, but during the process of reconstruction the corresponding wires on the other side of the arm, where the decedent stood, were in operation while new wires were being substituted. In the substitution, the new wires after being raised, were tied in with the old, on the insulators by the use of "short tie wires," and while doing this work he stood on a second cross-arm a little more than two feet below

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the first. Before tying the end pin wires the motor wire had to be untied, and after that had been attached to the insulator, retied. It is manifest from the testimony of his fellow workmen, that having secured the pole and end pin wires, he then had to step from the lower over the upper cross-arm, to reach a position where he could retie the motor wire. While making the change, he apparently would have incurred no danger, if the pole pin wire had been properly insulated. But about ten inches from the cross-arm, and attached to this wire, over which a few turns had been taken, were the remains of a discontinued copper "tap wire," which had been cut off leaving a very short projecting end. On changing his position, he was obliged to step over the tap wire which had become charged with the alternating current, when its end penetrated his body at the groin. It could have been inferred from the different descriptions of what followed, that from the shock he either fell upon the wires, or instinctively to prevent falling, almost simultaneously grasped one of them, making a short circuit through which the electricity passed, causing his death. It is further stated, that when the workmen began they all knew the cause of replacement, and that while reconstruction was in progress, the defendant would supply electricity for lighting through the pole and end wires in use at the time of the accident. The decedent, who was a practiced and skilful workman, had been informed of these general conditions, and must have been aware of the danger. During readjustment, the arrangement of the various wires, the shifting from one position to another required while fastening them, the bare wire in proximity to his person alive with electricity, were not only clearly visible, but in the light of his general knowledge, obvious. But if these conditions are uncontroverted, the plaintiff contends that they did not embrace the remains of the tap wire. The day, however, was clear, and even if this wire, originally bright, had become oxidized, resembling in color the pole pin wire, yet from where the decedent stood on the lower cross-arm, it was not only unconcealed, but immediately within his vision. Nor is this all. He was not hurried while tying the wires, but permitted to perform the work in his own way, with an opportunity of unrestricted observation which the dangerous environment demanded. If generally the employer, or those who under the statute stand in his place, owes a duty to an employee to warn or instruct him as to abnormal dangers, this duty is not violated, where from either the character of the work, or other sources, the employee is possessed of all the information which the employer could have furnished regarding such perils. Because of his previous knowledge, experience and means of ascertaining the obvious conditions under which his work must be performed, the decedent had been put in possession of all the elements of danger attendant upon his employment. The failure of the defendant or of its foremen, who could have been found to have been entrusted with superintendence, to instruct the decedent, where for these reasons no instructions became necessary, furnished no evidence of the defendant's negligence; and a verdict in its favor was rightly ordered.

Pembroke v. Cambridge Electric Light Co. (Mass.), 84 N. E. Rep. 331.

Authority to Empower Electric Company to Use Highways

The question arose upon the right of the Board of Supervisors to authorize electric company to use a highway. The court said in part:

The first question to be settled is, therefore, whether the lighting of the highway tends to facilitate and accommodate travel? In other words, does it promote the use for which a highway is dedicated, and hence included within the scope of the control of the board of supervisors over the highways, which is delegated by the provisions of the statute? The precise point has not been decided by our Supreme Court, but we are not without valuable suggestions from other jurisdictions, and we are aided somewhat by the opinions of standard authorities upon the subject.

In § 331, Joyce on Electric Law, we have an epitome of various decisions as follows: "Although a rural highway may not be subject to the same burdens or easements as city streets, yet in the dedication or appropriation as a highway it is made impliedly subject to such uses as the public may in the future require. The distinction as to the use of city streets and highways arises out of the necessary requirements of the public in the use made of them. We have seen that in the case of telegraph or telephone lines upon rural highways the weight of authority supports the conclusion that they constitute an additional servitude. In the construction and maintenance of poles and wires of an electric lighting company upon which are supported wires and lamps for the purpose of lighting the highway, however, there is a use different from that of the telegraph or telephone lines. In the case of the latter

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the poles and wires are not used in any sense for a street or highway purpose. The primary object of the highway is for the use of the traveling public, and any reasonable means tending to promote the safety and convenience of travelers is a proper use. The lighting of many of the country highways may not be necessary, yet in a large number of cases a rural highway, especially where a main avenue of connection with a large city, may be used to such an extent for the purpose of travel that the lighting thereof may be such a benefit to the traveling public, and so promote its safety and convenience, that it may be said to be a necessity, and be within the proper uses to which a highway may be devoted, and for which an abutting owner is not entitled to a compensation."

We are satisfied that within the spirit and purpose of the law the lighting of an urban or suburban highway may be considered incidental to the use contemplated by the dedication; that it tends to promote the comfort, convenience, and facility of travel over the highway; that the determination of the necessity for said lighting in any particular case is clearly within the authority of the board of supervisors or other local legislative body charged with the duty "to maintain, control and manage" the public highways; that the franchise in the case at bar was granted for a "lawful purpose"; and that the action of the said board is not subject to revision by the court in the absence of any showing that there has been an abuse of discretion or excess of jurisdiction in said action. We understand that the conclusion from the foregoing statements is not affected by the consideration that the poles and wires are to be used for private purposes as well as for the illumination of the public highways.

Gurnsey v. Northern California Power Co., 94 Pac. Rep. 858.

Liability for Death or Injury from Electric Current, Continued.—Duty and Liability to Licensees and Trespassers—Employees of Other Companies, Continued

As was said more at length earlier in this series of articles, the liability of the electric company for injuries depends upon the violation of duty or contract. Ordinarily, and in the cases we are now considering, it depends upon the violation of legal duty. This duty requires the owner or conveyor of an electric current to use all reasonable precautions to prevent injury to those who might rightfully expect to come in contact with its wires. We have considered the matter heretofore from the standpoint of persons who have been employed by other companies to do some work about the electric company wires, but who are not in any direct relation with the electric companies.

The case of Ryan vs. St. Louis Transit Co., 190 Mo., 621; 89 S. W. 865, presents a unique phase of the same subject and states a rule which is well applicable to the case at bar, showing clearly that the relation does not depend upon the contract. Ordinarily, in this class of cases, the person injured is in the employ of some other wire line company, but in the Ryan case, the person injured was employed by an independent contractor, engaged in putting in an oiling system for the electric company. This work was done in the basement of defendant's power house. The employee of the contractor was engaged in putting in a pipe aided by another employee. Plaintiff's intestate employed by the independent contractor working on this pipe was standing on a piece of tile conduit which, of course, insulated him, but permitted one hand to rest upon the pipe with which he was working. The wrench which was held in his other hand in the course of turning the pipe worked against the conductor at the point where the insulation was softened. It broke through this softened insulation and caused a current to flow through the body of plaintiff's intestate which resulted in his death. The Supreme Court of Missouri, after reviewing a number of cases, laid down the rule:

It is to be noted that there were no contractural relations between the deceased husband of the plaintiff, and the defendant transit company, but it is undisputed that the deceased was upon the premises of the company with its knowledge and consent, and to do a work for which the company had contracted with the employer of the deceased. When the defendant company made its contract with the Cullen & Stock Heating and Ventilating Company to install the oil system in the defendant's powerhouse upon plans and specifications prescribed by itself, it knew and was bound to anticipate the necessity under which the Heating and Ventilating Company rested of sending its employees upon its premises for the purposes of installing the pipes upon which the deceased was working when he was killed, and hence the duty devolved upon the defendant of keeping the electrical wires, near which the deceased was required to work in the performance of his duty in installing the oil pipes, so insulated and protected as to be safe for the deceased to work in their vicinity.

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Concerning the liability of the company, under the circumstances, it was held that the accident was one which the company could have reasonably anticipated and that it was bound to keep its cables reasonably insulated, saying:

It was agreed on all hands that the insulation on these cables was safe enough when normal, but was shown to be of a kind to be easily affected by the extraordinary temperature to which the transit company knowingly and continually subjected them, and knowledge of the character of the insulation installed by itself, of the conditions under which it was maintained, and of the probable effect of those conditions on the safety of the insulation, must be chargeable to the defendant company. It knew, when it sent the plaintiff's husband to work about these cables, the kind of insulation it used, and being in the exclusive control of the basement, the jury was justified in inferring that it had in fact become soft and imperfect.

Concerning the subject of contributory negligence, the court held the deceased free from such negligence, saying that he had a right to assume that the wires were safely insulated and that he could work about them without endangering himself, further saying:

It must be held that the company in contracting for the work of installing the oil pipes anticipated, or in the exercise of ordinary care were bound to anticipate, that these workmen while in the course of their employment would touch or come in contact with these cables, and therefore the principal contention of the defendant, that it could not have reasonably anticipated the occurrence of such an accident as this, appears to us entirely untenable, but on the contrary the want of proper insulation of these cables was the proximate cause of the injury to plaintiff's husband.

A case in principle like this one is Kennealy v. Westchester Electric Ry. Co., 82 N. Y. Sup. 823. In this case the plaintiff was working for a contractor who had been employed by the railway company to paint its poles. The court held that the defendant was obliged to use reasonable care to protect the employee of the contractor engaged in painting the poles, from injury. The theory of the plaintiff's case in this action was that the accident was due to defective insulation, defendant having been injured by his arm coming in contact with a feed wire while he was engaged in sand-papering one of the poles preparatory to painting it. The trial court held that no negligence could be predicated upon the failure to properly maintain and inspect the feed wire after it was put up, and the defendant's failure of duty must be based upon the defective construction. The jury found that the defective condition existed when the wire was put up, and it was held by the Supreme Court, Appellate Division, that the evidence justified the finding. We do not think that the conclusion reached by the trial court is justified by the ordinary rules of law, but think that the rule laid down in the Missouri Supreme Court the correct one and that when a wire line owner sends an employee of an independent contractor to do work which will necessitate him coming in contact with their wires, it is the duty of the wire line company to have the wires in such condition as will not endanger his life or limb should he come in contact with them, unless there is such in their appearance as will warn him of defects; that is to say, if the wire is apparently insulated so that he may reasonably expect to touch it in safety, the owner of the wire ought to know whether the insulation is safe or not, and its failure to possess that knowledge we believe, is negligence which ought to submit it to damages. If this liability is one which the electric company does not care to assume, then it should give warning to the servant of the independent contractor that if he comes in contact with the wires he does so at his own risk and must avoid them at his peril.

The Economical Electric Lamp Company, of 96 Warren street, New York City, makers of the well-known Economical Turn-Down lamp, in addition to their regular types of "Pull String" and "Turn Bulb" lamps, are now placing on the market a new type known as their No. 7. This new lamp is a "Three Point" lamp which can be turned from 16 to 1 c.p. and out, or from 8 to ½ c.p. and out. The No. 6 is the same type of "Three Point" lamp operated by a long cord with a switch on the end of same. They have an attractive booklet describing their complete line of turn-down lamps, which will be sent on request.

The Mutual Benefit E. L. & Pr. Co., incorporated under the laws of the State of New Jersey, was granted a franchise by the Jersey City Board of Aldermen on May 26, 1908, to do business in Jersey City, N. J. The Mutual Company are incorporated for $2,500,000 and have agreed to run wires underground and to make a maximum rate 25 per cent. less than that charged by the company now operating in that territory.

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THE NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION

Seventeen hundred and eighty-eight delegates were officially registered at the thirty-first convention of the National Electric Light Association, held in the Auditorium Hotel in Chicago, May 19th to 22nd, and although it was estimated that at least three or four hundred delegates did not register, the above figure is the record number since this Association was formed in 1885.

At last year's convention, held in the New Willard Hotel in Washington, June 4th to 7th, sixteen hundred and seventy-five delegates were registered, and the convention previous to the one in Washington was held at Atlantic City, N. J., June 5th to the 8th, fourteen hundred and sixty-one delegates were registered.

At this writing, the aggregate membership of the National Electric Light Association, including all classes, is thirteen hundred and twenty-seven—the increase for the year, or since the last convention, being one hundred and twenty-four, or 10.3 per cent.

The above figures show the healthy condition of this Association, which represents the interests of the electric lighting and power stations of this country.

The total number of central stations of the United States is now five thousand and thirty-seven, and when the three hundred and ninety-six Canadian and the sixty-two Mexican central stations are added, the total number for the North American continent is brought up to fifty-four hundred and ninety-five, every one of which is eligible for membership in the National Electric Light Association, as a class A member.

When it is appreciated that the above central stations represent a capital invested of over $850.-

A SESSION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION CONVENTION.

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000,000, with a yearly revenue of nearly $200,000,000, the power and the influence of this association place it at the head of the electrical field.

On Sunday morning, May 17th, special trains from all parts of the east and west started with their hundreds of delegates for the thirty-first convention, and by Monday noon, May 18, the corridors of the Auditorium and the Auditorium Annex in Chicago, were crowded by members of all classes of the association from all parts of the country.

PRESIDENT W. C. L. EGLIN.

The first feature of the convention program was the opening of the electrical exhibition on the evening of May 18 at eight o'clock. Mr. Dudley Farrand, president of the association, in company with Mr. F. H. Gale, manager of the Publicity Department of the General Electric Company, and chairman of the exhibition committee, closed the switch which caused the entire hall to burst into illumination through tungsten lamps, this new type of lamp being used exclusively for lighting the big exhibition hall which was on the ninth floor of the Auditorium Hotel. Each of the booths occupied by the exhibitors was beautifully and uniformly decorated in varying shades of green, and all the color effects were brought out by the white light of the thousands of tungsten lamps which were furnished for this occasion by the General Electric Company and the National Electric Lamp Association.

A big reception in the Auditorium Annex then followed the formal opening of the exhibition, and it was estimated that over two thousand delegates and ladies attended this function, the guests being received by Mr. Samuel Insull, of Chicago, chairman of the reception committee, assisted by Mrs. Insull and the officers of the association.

The real business of the convention was opened on Tuesday morning at half-past ten o'clock, by President Dudley Farrand, who, as soon as the meeting was called to order, made his opening address.

ADDRESS BY PRESIDENT DUDLEY FARRAND.

Our membership is now: Class A, 664; Class B, 394; Class D, 151; Class E, 93; honorary, 25; total of all classes, 1,327—an increase during the year of 124, or 10.3 per cent. Our finances are in good condition.

During the period which has elapsed since our last annual meeting we have experienced serious business depression. The volume of general business of the country has been very considerably reduced and the interests of our customers, which are always our greatest interest and concern, have required serious retrenchment. This has affected the amount of our business to varying degrees everywhere. But I am decidedly optimistic on the subject of an early return to increased business and renewed prosperity. In addition to the financial and business stress, the interests which we represent have been subjected to the natural and logical results of an agitation having an indefinable source, but extending practically all over the country. This agitation, wearing the cloak of reform, has for its objective the creation and establishment of a multiplicity of commissions, national, state and municipal, and seeks not only a reasonable regulation and control,

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as stated in some of the arguments in favor of the movement, but it actually prevents progress by unreasonable interference with private interests, stifles individual initiative, and in many instances favors acts which are no less than actual confiscation.

We are all, I hope, law-abiding citizens, and yet if commissions or unreasonable legislation of any kind are thrust upon us, I see no reason why we should not be free to protest and endeavor by all reasonable means and to the best of our ability, to defeat the enactment of measures designed for political purposes and tending to undermine the very foundations of our investments.

Conceding, for the sake of argument, that certain corporations have in the past adopted policies or schemes of financing which have been contrary to public policy, there are undoubtedly many companies, and I think a large majority of them, whose capitalization and investments represent dollar for dollar, whose rates have been equitable and reasonable, whose treatment of customers and the public has been fair, whose system of accounting has been adequate to local requirements and has shown sufficient details of operating and financial transactions for all practical purposes; and yet, under some of the proposed schemes of regulation and control, every such company, no matter what its history, its rates, or its standing with its customers, is to be subjected to various kinds of supervision and regulation, the details of which are very largely left to the discretion of a commission whose members, in most cases, are not familiar with the subjects in hand and have never had actual experience in the particular business over which they are given so much power.

Take, for instance, the case of rate regulation; the most conspicuous example is found among the enactments of our more recently constituted commissions in the establishment of a uniform maximum rate for a given locality. Such action has never been justified from an engineering or operating standpoint. I claim that the establishment of an arbitrary maximum rate, without other qualification, such as time, quantity, or hours of service, is entirely contrary to the fundamental principles governing the cost of the service, and can only be justified on the law of averages, in which the loss from one customer must be added to the cost of supplying others. It is self-evident that the lower the maximum the higher the minimum.

The question of municipal ownership, which has been agitated for some years, has been less prominent of late, owing to the financial stringency and the inability to sell bonds readily. I am firmly of the opinion that if the status quo can be maintained for a short while the great majority of municipal lighting plants will be declared failures only those being retained which have exceptional local facilities permitting reduced operating costs.

Let me call especial attention to and urge the necessity of a closer relation with the several state associations.

Suggestions have been made from time to time toward forming sub-organizations to take up special subjects and holding separate meetings. The present administration, however, has always looked with disfavor on such separate or interior organizations as being unnecessary and tending to sap or undermine the association. In response to a genuine request to hold separate meetings, and in order to try the experiment, arrangements have been made and another meeting room provided, and parallel sessions will be held there on Wednesday, for accountants, under the auspices of the committee on uniform accounting, and on Friday for part of the commercial day work under the auspices of the commercial day program committee. It is hoped that some such arrangement will permit specializing by committees on any subject or to any extent desirable without the necessity of a separate organization.

On the invitation of the President of the United States, I attended a conference at the White House, held May 13, 14 and 15, to consider the conservation of natural resources. While at the conference I joined with the presidents of four of our leading engineering associations in urging the appointment of a suitable committee of engineers to investigate the subject thoroughly and recommend such action as would be best adapted to accomplish the desired object in a seasonable manner, and avoid the errors of too hasty action. I would therefore recommend the appointment of a representative by this association to take part in such further conferences as are quite sure to be held.

I want to thank the members for the many courtesies and words of encouragement received during the year, and the officers and members of the executive committee, not only for close attention to the interests of the association, but to the prompt response and hearty co-operation in all matters where it has been suggested that they could be of assistance. I want to acknowledge especially the effective co-operation and wise counsel in many ways of our secretary and treasurer, Mr. W. W. Freeman, who, in addition to his regular duties, has met with your president in the offices of the association at least

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once each week during the year. No statement would be complete, however, without giving proper credit to our assistant secretary and treasurer, Miss Billings, and the members of the office staff for the ability and conscientious efforts throughout the year in the interests of the association and its members.

At the conclusion of the president's address, Mr. W. W. Freeman, secretary of the association, made several announcements and read the usual letters of regret from a number of prominent men directly and indirectly connected with the work of the association, who were unable to be present on this occasion.

The first paper presented was the report of the committee on progress, by Mr. T. Commerford Martin, of New York City, editor of the *Electrical World*.

Following Mr. Martin's most excellent paper was one on "Distribution in Suburban Districts," by Mr. J. H. Lukes, of Chicago, which, at its conclusion, was discussed by Mr. F. Osgood, of Newark, N. J.; Mr. H. B. Gear, of Chicago; Dr. Charles P. Steinmetz, of Schenectady; and by Mr. H. M. Edwards, of New York.

The paper presented by Mr. Paul Lupke, of Trenton, N. J., entilted, "Tape," was read by Mr. T. Commerford Martin.

"Grounding of Secondaries" was the subject of the next paper, presented by Mr. W. H. Blood, Jr., of Boston, a former president of the association, and the following resolution was adopted:

"*Resolved*, That it is the sense of this meeting that it is desirable to have inserted in the National Electrical Code a rule making mandatory the grounding of alternating-current secondary circuits up to and including 150 volts, and a provision making prohibitory the grounding of secondary alternating-current circuits carrying in excess of 150 volts."

The committee realizes that the rule, as at present worded, may not be perfect, yet it believes that a step in advance has been made, and that, by protecting, as the rule will, over ninety-nine per cent. of the lighting circuits which ordinarily run at 150 volts or less, the number of fatalities will be greatly reduced. The only serious point at issue seems to be whether the limiting voltage shall be 150 or 250.

The proposed changes in the National Electrical Code rules then followed. Mr. Blood's paper was further discussed at the afternoon session by Mr. H. B. Gear, of Chicago, and Mr. J. W. Cowles, of Boston.

Mr. Henry L. Doherty, of New York, a former president of the association, read the report of the committee on organization.

"Our present organizations have grown up more or less indiscriminately, and no comprehensive plan has ever been proposed for a thorough organization of the industries throughout the country. The problem of proper organization may at any time become one of vital importance, and it is greatly to be desired that the National Electrical Light Association should be the basis of a complete organization of the entire business of the country, before new organizations have been formed, or before existing organizations can extend their scope of operation, or inaugurate plans that will make the eventual consolidation of the central station industry in one organization an impossibility."

Mr. Doherty then presented his plan of reorganizing the association, and the changes proposed in the situation are briefly as follows:

(1) Geography of sections. These sections will correspond to the present state of territorial organizations, and will represent new organizations to cover districts that now have no state or territorial organization.

(2) That provision be made for half sections. Many of the central stations already have engineering clubs, progress clubs or study clubs. It is the purpose to organize these clubs as a lasting branch of the National Electric Light Association, and to create others where such clubs do not exist.

(3) That provision be made for the formation of national special sections. The purpose of these national special sections will be to permit men interested in certain lines of work to organize themselves to promote their special branch of work, and is intended to cover, for example, lawyers, accountants, purchasing agents, new-business managers, or any and all sub-divisions of central station work.

(4) The authorization of national conferences. These national conferences are to be authorized on special subjects, from time to time, upon application of fifteen or more Class A members.

(5) The exhibits to be provided for, whereby electrical shows or exhibits may be held under the auspices of the National Electric Light Association.

(6) That contests be provided for, whereby the relative merits of competitive apparatus used in central station industry can be demonstrated under the direction of an impartial tribunal, and by an organization of sufficient authority and prestige to make such contests well worth their expense.

After the reading of this report, it was moved by

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Mr. W. H. Blood, Jr., that the incoming administration appoint a committee on this subject, to report at the next annual convention. Mr. Blood stated that the proposed changes were so radical, that there should be plenty of time for their careful consideration.

This motion, however, was amended by Mr. E. H. Davis, of Williamsport, Pa., to have the committee appointed at once and to report, if possible, to the present convention. This amendment to Mr. Blood's motion was carried, and Mr. W. W. Freeman, Mr. F. M. Tait, Mr. D. A. Ferguson, Mr. W. H. Blood, Jr., and Mr. Arthur Williams, were appointed by the president.

The next paper, entitled, "Power Development in Small Stations," prepared by Mr. Charles Robbins, of Pittsburg, and by Mr. J. R. Bibbins, of the same city, was read by Mr. Robbins. This paper, like many of the other important and interesting papers presented at this convention, is too valuable to be merely abstracted, and will be published in full in a subsequent issue of THE CENTRAL STATION.

"The Small Station and Its Economical Operation" was the subject of another interesting paper by Mr. J. T. Whittlesey, of Newark, N. J., and Mr. Paul Spencer, of Philadelphia, and was read by the former. A plan for a station in a city of twenty thousand population or less was outlined, and will be published in full in a subsequent issue. This paper was discussed by Mr. C. A. Howlett, Mr. C. M. Young, Mr. E. L. Brown and Mr. R. S. Searle. Mr. A. J. Campbell, of New London, Conn., then brought up the subject of the Question Box of the National Electric Light Association, and recommended that the association publish a hand-book, and that the publication of the Question Box should be continued in the monthly bulletin of the association. Mr. Campbell was complimented for the highly efficient manner in which he carried on his work as editor of the Question Box in the association bulletin, and Mr. Campbell's recommendations were referred to the incoming administration.

Mr. H. M. Edwards, of the New York Edison Company, presented the report of the committee on a uniform system of accounting for electric lighting companies, and said that the proportion of small companies is so great that unity in accounts can only be accomplished in essentials, and presented classifications of expense and income accounts. Mr. Edwards reported that, since the last meeting of the association, the Public Service Commissions of the State of New York had completed their organizations, and through their respective bureaus of statistics and accounts have been preparing a classification of accounts to be followed by all the companies within their jurisdiction. For the street railway business, the commissions have adopted the system of the Interstate Commerce Commission, but for gas and electric light industries they will formulate systems of their own. The accounting committee of the National Electric Light Association has kept in touch with this work of the commissions, has tendered its aid, and this aid the commissions have accepted and have consulted the committee on all features of their plan. Tentative classifications have been adopted by the commissions, and Mr. Edwards's committee desired the instruction of the association as to its attitude toward them.

A set of resolutions sent by Dr. A. E. Kennelly, secretary of a joint committee of the sub-committee of the American Institute of Electrical Engineers, American Gas Institute, and the Illuminating Engineering Society, on the question of the adoption of an international standard candle unit, was presented and read. There is a growing need of a common unit desirable to have such a standard international. The resolutions, in which the National Electric Light Association concurred, on motion of Mr. Arthur Williams, of New York, approved of a common candle power unit, and refers the matter to the United States Bureau of Standards, to formulate a standard of about the average value of the Government laboratory standards of the United States, Great Britain and France, although no definite recommendation of the value of the candle-power standard was made by Dr. Kennelly. After the reading of this paper, adjournment was taken until Wednesday morning.

Wednesday morning's session was opened shortly aften ten o'clock, and the paper on "Photometric Precision," prepared by Mr. A. E. Kennelly, and Mr. S. E. Whiting, was read by Mr. Preston S. Miller, of New York, in the absence of the authors. Following this paper and its discussion, a very excellent paper on "Low-Pressure Steam Turbines," by Mr. J. W. Kirkland, of Schenectady, was presented. Mr. Kirkland drew attention, in this paper, to an engineering scheme that will effect a remarkable gain in central station capacity and economy, without involving the abandonment of existing apparatus, and with a minimum of additional investment. The low-pressure turbine, Mr. Kirkland claims, affords a means of increasing the capacity of existing central stations that are equipped with reciprocating engines, and at the same time reducing

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coal consumption. Furthermore, the increased capacity will be, in every case, secured at a less capital cost than by installing additional high-pressure generating apparatus. These advantages are such as to warrant a serious consideration of low-pressure turbines in connection with plans for increasing the capacity, or improving the economy of any engine-driven plant.

This excellent paper will be reproduced in full in a later issue of THE CENTRAL STATION.

At the conclusion of the discussion of Mr. Kirkland's paper, Mr. W. C. L. Eglin, of Philadelphia, presented in abstract the report of the committee on gas engines, accompanied by a number of lantern slide views of various American-built units. Prof. C. E. Lucke, of New York, in discussing the above report, stated that the gas engine is as reliable and economical a prime mover as any in use. It is not to be considered as the universal power producer of the immediate future. In certain fields it has marked advantages. In general, a gas engine installation does not vary as much with size in cost per horse power, as is true with steam engines. Hence, in large plants a gas engine installation cannot be expected to operate as economically as its steam engine rival. But in small plants, undoubtedly economy results from its use. A point of importance not to be overlooked, is the readiness with which gas engines can be started and stopped. They can generally be started and put under load inside of one minute, which makes it particularly advantageous to use small units and run them at maximum efficiency. The report was further discussed by Mr. J. R. Bibbins, of Pittsburg; Mr. H. Almert, of Wichita; Mr. Davis, of the Allis-Chalmers Co., and Mr. Freund, of the Illinois Steel Co.

Following this paper, Mr. Louis A. Ferguson, chairman of the committee on meters, read the report of that body on this subject.

"Your committee," said Mr. Ferguson, "cannot urge too strongly the very great importance of thorough study and vigorous attention on the part of each company to the subject of metering. From the view-point of first cost, the meter forms a very large part of the total investment for each of the many very small consumers. From the view-point of operating expense, the care, maintenance and reading of the meter, and the billing, is a large part of the expense for these same very small consumers. From the view-point of income, an average difference of a very few per cent. on the whole output of any one company, is a very serious matter, indeed, all of which indicates that the complexity and importance of this matter is such as to require judicious and expert attention from every company."

The report further states that the association should take up at once the matter of meter-regulating ordinances, which might serve as a basis for member companies to the end that such ordinances, when and where enacted, be uniformly just and equitable to the consumer and to the public. The Wednesday morning session was adjourned after the discussion of this report on meters.

There being no meeting on Wednesday afternoon, a large number of the delegates were taken on a visit of inspection to the Fisk street station of the Commonwealth Edison Company, of Chicago, in special cars, and were met at the station by Mr. Samuel Insull, president of the company.

Wednesday evening's session was called to order shortly after eight o'clock, and the first paper presented was on "Series Incandescent Systems with Tungsten Lamps," by Mr. P. D. Wagoner, of Schenectady.

At this session, Mr. W. W. Freeman also presented his interesting paper, entitled, "The Status and Commercial Possibilities of High-Efficiency Lamps."

Mr. W. H. Blood, Jr., of Boston, the insurance expert for the association, read his report.

Much interest was shown in the report of the committee on public policy, presented during this session.

Mr. Arthur Williams, of the New York Edison Company, chairman of the committee, instead of making the report himself, handed this honor over to Mr. Samuel Insull, who was greeted with great applause as he took the stand. The report was an extensive one, and contained much of value to the members. The committee consisted of Mr. Arthur Williams, the chairman; Mr. E. W. Burdette, Mr. Walton Clark, Mr. Henry L. Doherty, Mr. J. W. Lieb, Jr., Mr. J. B. McCall, Mr. Samuel Scovil, and Mr. Charles L. Edgar, the secretary of the committee being Mr. W. H. Gardiner, of New York.

After the session of Thursday morning was called to order, Mr. Charles R. Huntley, of Buffalo, a former president of the association, arose and moved that, out of respect to Mr. Robert C. P. Holmes, who died at an early hour Thursday morning, the result of an assault of ruffians who robbed him, the morning session be adjourned.

President Farrand stated that Mr. Huntley's motion admitted of no debate, and the session was adjourned until half-past one that day.

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At the opening of the session Thursday afternoon, Mr. M. S. Seelman, Jr., of the Brooklyn Edison Company, spoke of the methods of handling the tungsten lamp situation in his city. "In view of the fact that the supply of tungsten lamps would be, at least for some time, limited, and with the idea that it would be more profitable to utilize such lamps as we could secure, in replacing gas illumination, thus adding to our revenue, rather than to place them in present sockets, where they would be likely to reduce current consumption, we decided to organize a separate company to exploit the tungsten lamps and especially the 100-watt lamp, among gas consumers.

"The Tungsten Lamp Specialty Company was therefore formed, with the clear understanding that it must carry itself and pay its own way. As it was exclusively gas burners this new company was after, it was deemed advisable to present to prospective customers a uniform price covering a complete tungsten equipment, including wiring and the supply of proper fixtures, reflectors and lamps. It was not deemed wise for the company to do its own wiring, as the Edison Lamp Company preferred to avoid all complications with the local electrical contractors, and to rather secure their co-operation than their ill-will. Specifications were therefore drawn, covering wiring in moulding for a maximum of four 100-watt lamps, window lights and a switch for each store circuit, contractor to hang fixtures which were to be furnished by the company. These specifications were submitted to all contractors in good standing in Brooklyn, and resulted in the Tungsten Lamp Company securing a blanket price of two dollars per outlet, and fifty cents per switch. Types of single-light fixtures were adopted which cost the company from forty-five cents to one dollar and twenty cents, according to the style and length of same. The reflector adopted as a standard for general use was Holophane No. 7391. The price of the 100-watt lamp, when sold separately, was fixed at $1.75.

"The Tungsten Lamp Specialty Company has been operating on this basis for about seven weeks, and during that time it has secured in Brooklyn fifty contracts covering the installation of three hundred and twelve tungsten lamps. Of these, forty-two contracts replaced installations exclusively gas, while eight replaced gas in installations partially electric. The majority of these stores are now lighted by tungsten lamps, and it is exceedingly gratifying, as well as somewhat unusual, to find so many satisfied customers, for in each case the customer is delighted not only with his illumination, but with his bills."

"The Commercial Day Program," relating to business-getting methods, prepared by Mr. C. W. Lee, of New York, was commenced at this session. Mr. Henry L. Doherty, of New York, presided.

Mr. Louis A. Ferguson, of Chicago, delivered an address on the relationship between the engineering and the commercial departments. Mr. Henry J. Gille, of Minneapolis, presented a paper entitled, "Preparation for a Campaign." It was discussed by Mr. J. T. Maxwell, of Philadelphia; Mr. F. M. Tait, of Dayton; Mr. R. M. Searle, of Rochester; and Mr. Arthur Williams, of New York. At the conclusion of the discussion Mr. Stannard, of Denver, moved to have appointed a committee of five to formulate a uniform system of records for new business departments, which motion was adopted. During this session, Mr. Doherty announced that Mr. J. Robert Crouse, of Cleveland, "a man who was practically unknown to us three years ago, but who, by his aggressive work, has commanded our complete respect, and who, by his charming personality, has commanded our most sincere regard," had been taken down with nervous prostration, largely due to work done in behalf of the association, and which was purely a work of love. Mr. Doherty suggested that a committee be appointed to draft resolutions of sympathy, and Mr. Arthur Williams, of New York, made such a motion. The chair appointed the following gentlemen to act on this committee: Mr. Arthur Williams, Mr. Percy Ingalls and Mr. George Williams, and the following are the resolutions adopted:

"Whereas, This association hears with deep regret of the illness of Mr. J. Robert Crouse, who has been most active as a member of the association, constantly, devotedly and unselfishly promoting its interests in every way possible; be it, therefore,

"*Resolved,* That we tender to Mr. Crouse our deepest sympathy at this time, with our devout wishes that his recovery may be speedy and complete, and that we may be able to welcome him again at our next convention."

Mr. L. D. Mathes, of Dubuque, presented a report on "The Display Room," in which he stated that this feature of central station activity dated from the Boston Edison Company's display in 1898. The report described the appointments and methods of various display rooms. This subject was further discussed by Mr. S. A. McCullough, of Raleigh, N. C.; Mr. A. J. Campbell, of New London; Mr. H.

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W. Hillman, of Grand Rapids; and Mr. William Chandler, of Michigan.

Mr. Frank H. Gale, chairman of the exhibition committee, presented his report to Class D members. Mr. Gale stated that all expenses had been provided for by the sale of space at the exhibition, and that a substantial balance remained to the credit of the committee. All the members of the exhibition committee which did such excellent work, were re-elected. To serve three years: Mr. James I. Ayer, of Cambridge, Mass.; Mr. W. S. Heger, of Milwaukee; and Mr. Benjamin Wall, of Brooklyn. To serve two years: Mr. Rodman Gilder, of Ampere, N. J.; Mr. J. C. McQuiston, of Pittsburg; and Mr. H. M. Post, of Chicago. To serve one year: Mr. S. E. Doane, of Cleveland; Mr. C. P. Frey, of Newark, N. J.; Mr. F. H. Gale, of Schenectady, N. Y.

Mr. Gale was re-elected chairman; Mr. Post, secretary; and Mr. Walter Neumuller, of New York, assistant secretary.

Friday, the last day of the convention, commenced with two parallel sessions—one in the banquet room on the sixth floor of the Auditorium, devoted to the commercial day program, and the other in the regular assembly hall on the ninth floor of the hotel, for the continuation of the regular papers on engineering and operating subjects. The first feature in continuing the commercial day program was the reading of Mr. Parker's report on advertising. Following this was a paper by Mr. Percy Ingalls, of Newark, N. J., on "Publicity," which was read by Mr. C. W. Lee. Mr. Ingalls stated that, "in these days of public service commissions, when public utility companies are being investigated and drawn into the lime-light through the medium of the public press, it is within the province of every lighting company to pave the way favorably for such investigations. Even though these companies can successfully weather the bombardment of cross-examination and unfavorable newspaper comment, still half the battle will be won at the outset if the fangs of such unfavorable publicity can be neatly and cleverly drawn and the poison eradicated. This can readily be accomplished through the medium of the newspapers and by taking the public into the confidence of the company.

"As corporate control has been shrouded in mystery for many years past, and as there has been no definite reason for secrecy in the operations of public-utility companies, the best-known officials today are acknowledging the error of their ways and throwing the spot-light of publicity upon the operations of their various companies.

"We are at the threshold of a new era, and public-utility companies are not only beginning to realize this, but have begun to act aggressively in paving the way for favorable public opinion. During the last two years, with municipal ownership and franchise agitation in the air, too many companies have failed to act until 'the ax had fallen;' then, becoming desperate, publicity methods were resorted to at the eleventh hour, with only partial success.

A popular form of publicity has been through daily talks in fair-sized newspaper display space. In this space the company has been able to explain its methods, tell the object of its existence, and handle a mass of interesting facts and figures, thereby creating renewed interest in the operations of the company. If this copy is handled in a sincere way, it becomes productive of untold good."

Mr. Converse D. Marsh also made some very apt and interesting observations on this subject, in which he urged the managers of central stations who are seeking a fair deal from the press, to meet editors and reporters half-way, and not to hand them the old expression, "Come around to-morrow." If you put off the reporter on some point on which he may have some knowledge and on which his paper desires further particulars, you will probably be placed at a distinct disadvantage in print.

During this session there was a "council of progress," at which several well known speakers, among whom were Hon. Leslie M. Shaw, former Secretary of the Treasury; Mr. John R. Morron, president of the Diamond Glue Company of Chicago, and others, who are ready and willing to speak on any subject at the drop of the hat, aired their ideas on various subjects about as valuable to this convention, with its limited time, as a sun-dial would be on a ferryboat.

The "stick-to-it" sentiments expressed by Mr. Morron, the glue manufacturer, were, of course, more or less appreciated by those who were devoting their time to new-business getting.

"Creating demands for Electricity" was read in part by Mr. George Williams, of New York, who, together with Mr. Frank B. Rae, Jr., prepared this interesting paper.

An illustrated talk with the use of a stereopticon on "Outline and Sign Lighting" was then presented by Mr. Williams. These pictures created a great deal of interest, especially those showing the wonderful advancement made within the past year by the city of Scranton, Pa. A long discussion on the subject of sign lighting followed this interesting talk.

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Mr. Van Rensselaer Lansingh, of the Holophane Company of New York, presented a very interesting report on "Illuminating Engineering as a Commercial Factor," and illustrated his presentation with lantern-slide pictures.

Like all of Mr. Lansingh's work, it was the presentation of accurate recent results with lighting installations—a paper which will be reproduced in full in a subsequent issue of THE CENTRAL STATION.

While these commercial problems were being presented and discussed, the parallel session was taking place in the regular convention hall, where Mr. Robert S. Stewart, of Detroit, presented the report of the committee on protection from lightning. This report showed that the damage done by lightning to electrical apparatus was less during 1907 than during 1906. Mr. Stewart stated that one of the most important developments of the year was the aluminum electrolytic arrester. Laboratory tests on aluminum arresters are most remarkable, and the few plants heard from are satisfied with their performance in regular service. Whether the arrester will stand a direct stroke of lightning without injury is not known, but we know that no other arrester will take care of a direct stroke. The total life of the arrester is also uncertain. There is, however, no apparent depreciation in the arresters that have been examined after a year's service. The aluminum arrester is used with equally good results on direct or alternating-current circuits.

"The Value, Care and Maintenance of Meters" was the title of a paper presented by Mr. H. D. King, of Hoboken, N. J., in which Mr. King gave much valuable information on the subject of meter testing.

Mr. Paul Spencer, of Philadelphia, read the report of the committee appointed to define the term, "high-tension," or to mark, if practicable, the dividing line between "high tension" and "low tension." The report of this committee was that they had carefully considered the question raised at the session on Tuesday morning, as to the limitations implied in the term "high tension." They feel that the terms "low tension," "medium tension," "high tension" and "extra high tension" were purely relative, and that no definite voltage limitations could be set that would cover at all satisfactorily the various conditions to which these terms are applied. Therefore, in view of the purely relative value of the term "high tension," the committee unanimously recommended that no definite resolution attempting to place a limiting value on the term be adopted at this time by the association.

"A Specification for Line Construction on Poles Jointly Used by Electric Light and Telephone Companies" was the subject of a paper presented by Mr. Paul Spencer. Complete specifications designed for construction for voltages not exceeding 7,500 were given in the paper, and it was stated that these specifications had been adopted by the Bell Telephone Company.

Mr. W. D'A. Ryan, of Lynn, Mass., presented a very interesting paper on "Illuminating Engineering," in which Mr. Ryan stated that the tungsten lamp will undoubtedly revolutionize the general lighting field, and gave some results of practical tests to determine the costs and relative merits of various lighting systems, with a number of new devices. Mr. Ryan also presented the final report of the 1907 committee to consider specifications for street lighting.

The concluding session of the convention was held on Friday afternoon. This session was presided over by Mr. Henry L. Doherty, and was opened with a paper on the "Evolution of New Business Building," written jointly by Mr. George N. Tidd and Mr. Duncan T. Campbell, of Scranton, Pa. The paper cited examples of central stations that have continued methods of new-business getting during the recent business depression, and also made a strong plea for the up-keep of commercial departments and advertising. "The confidence of a community," say the authors of this paper, "is the greatest asset that any corporation, firm or individual can have. A commercial department with the right kind of solicitors employed, and a progressive and up-to-date company back of it, can gain and keep for the company the confidence desired. It can make 'boosters' out of 'knockers,' can put a smile where a frown has been conspicuous, and make the competitor without any commercial department look like a balloon returning to earth. No advertising can equal the advertising you get from your satisfied customers, and the ideal solicitor is the man who, by courteous treatment of the people on whom he calls, makes assistant solicitors of all his customers."

Mr. Becker's paper on the "Electrical Contractor" was then presented.

"Co-operation with experienced electrical contractors," says Mr. Becker, "is becoming more and more essential to the central station. It has gained the good-will of a closely affiliated fraternity, besides promoting the sale of electricity to a larger extent than before this co-operation existed. It is indeed gratifying to note the material change that

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has taken place in the relations of central station managers and the electrical contractors. The many novel methods and the energy displayed by a number of the contractors in various cities throughout the country, prove conclusively that the 'get-together' habit has grown with more rapidity and with satisfactory results."

Mr. J. E. Montague, of Niagara Falls, made a few remarks regarding the Co-operative Electrical Development Association. "In view of the financial and business situation during a large part of the past year," said Mr. Montague, "it has seemed impracticable to undertake seriously the accomplishment of the work outlined for this association for the year, and the matter of definitely completing the organization has been deferred, but the original informal organization has been maintained, with a view to expansion and increased activity as soon as conditions render it practicable to secure the active support of the manufacturers and central station companies generally."

In the absence of Mr. J. Robert Crouse, who is suffering from nervous prostration, brought about by the tremendous work and close application to the Co-operative Electrical Development Association, Mr. F. M. Tait, of Dayton, O., presented a brief report on "Co-operative Commercialism." Mr. Tait stated, that since the last National Electric Light Association convention, Mr. Crouse has confined his efforts to underwriting the one hundred and twenty-five thousand dollar for which he had committed himself before any subscriptions became binding. Up to October 15 of last year there had been underwritten $100,000, and Mr. Crouse at that time was confident of underwriting the entire amount, and would undoubtedly have done so had not the financial depression held up the proceeding, which is now in abeyance.

The "commercial day" sessions were a tremendous success, and a special vote of thanks was extended to Mr. C. W. Lee for the work he had done in bringing this particular feature to such a point of general interest.

During a special session on the last day of the convention, resolutions of thanks were extended to President Dudley Farrand, Vice-President Alex Dow, and W. C. L. Eglin, secretary and treasurer; W. W. Freeman, and to Assistant Secretary and Treasurer Harriet Billings; Mr. Frank H. Gale, chairman, and Mr. Walter Neumuller, secretary of the exhibition committee; Mr. George H. Porter, master of transportation; Miss Edith Myers, chief of the registration bureau, also received the thanks of the association for their efficient work in connection with the interests of the association. Three hearty cheers were given for President Dudley Farrand, who gracefully expressed his thanks for the courtesies extended to him, as well as the interest taken in this, the greatest convention in the history of the National Electric Light Association. In the final executive session the following officers were elected for the ensuing year:

President, William C. L. Eglin, of Philadelphia; first vice-president, Mr. Frank W. Frueauff, of Denver, Colo.; second vice-president, Mr. W. W. Freeman, of Brooklyn, N. Y.; secretary and treasurer, Mr. John F. Gilchrist, Chicago, Ill.

Members of the executive committee for the fall term: Mr. C. L. Edgar, of Boston; Alex Dow, of Detroit; Arthur Williams, New York; and for the unexpired term of Mr. Scovil, Mr. R. M. Searle, of Rochester, N. Y., was elected. The election of Mr. Eglin met with unanimous approval.

Mr. Eglin is known to nearly every member of the association, having served on a number of important committees, as well as having been an officer of the association during the last three years. The business experience of the new president has been in connection with the various electric lighting companies in Philadelpha, having been connected with the Edison Electric Lighting Company of Philadelphia in 1889, and with the various consolidated companies which finally centered in the Philadelphia Electric Company, which owns and operates all the electric lighting companies in and about the city of Philadelphia. Mr. Eglin occupies the position of electrical engineer for the Philadelphia Electric Company.

The Technical Publicity Association at its Annual Meeting, April 30, 1908, elected the following officers to serve during the ensuing year: President, C. S. Redfield, Adv. Mgr. Yale & Towne Mfg. Co., N. Y.; First Vice-President, Rodman Gilder, Publicity Mgr., Crocker-Wheeler Company, Ampere, N. J.; Second Vice-President, C. N. Manfred, Mgr. Adv. Dept., H. W. Johns-Manville Co., N. Y.; Secretary, H. H. Kress, Publicity Dept., A. S. Cameron Steam Pump Wks., N. Y.; Treasurer, H. M. Davis, Adv. Mgr., Sprague Electric Co., N. Y.; Members of Executive Committee, F. H. Gale, Chg. of Adv., General Electric Co., Schenectady, N. Y., and C. W. Beaver, Special Representative, Yale & Towns Mfg. Co., N. Y.

Twenty new members have joined the Association since the last anual meeting.

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The Central Station

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Entered at the New York Post Office as Second Class Mail Matter.

The Moving Sub-Station

While not referring directly to central station practice, the summer resorts, with their extra population at this time of the year, demand more light and power than usual. In order to accommodate the public living there, constituting hotel keepers, proprietors of pavilions and those living in cottages, some provision is necessary in the way of a sub-station. A solidly constructed sub-station would be rather expensive considering the sixty or ninety days' use to which it would be put. Therefore, in order to meet this difficulty successfully and still not enter into an expense which would be considered inordinate in comparison with the duration of the need, a suggestion arose last year, and is to be utilized this year, of building a moving sub-station, and shunting it to side tracks where it will remain in shape of a well equipped car, until the season is over.

In other words, a moving sub-station representing a car on wheels fully equipped to meet the requirements solves the problem most effectively. The fact that it can be readily transported makes its usefulness so great that no complaint can possibly be entertained against it on the basis of heavy initial investment, or inconvenience. The fact that in some summer resorts the lighting is very bad, has been due to two things: either that the wiring was so defective that the drop manifested itself in poor illumination; or, that the overload was so great, the lines manifested not only drop, but diminished pressure at the points of distrbution. Circumstances such as these call for radical remedies if possible, and the use of a moving sub-station which can be transported back to the central station or power-house after it has done its work, is as ingenious as it is useful.

Since electricity has been introduced in shore resorts or in interior summer centers, the demand has systematically increased and a point been reached where deprivation of the advantages of electricity would become a calamity. The central station is generally situated at a point far enough away to make it somewhat expensive to supply electricity without charging a profitable rate. The rate sometimes seems high, but when the circumstances are considered, this is not the case, for the time of service may not exceed three or four months all together. In such cases where State laws limit the charges, it is easy to see that it is necessary to hold down the expense and the investment when accommodating the public at places from which they will soon move.

Daylight and Artificial Light

In speaking of these two forms of light, it is understood that they differ in certain respects. For instance, our nearest approach to daylight is found in the arc; but it is admitted by scientists that the lights from the arc merely approximate that of the sun, and is not identical with it. The question, therefore, arises in considering what is called daylight in comparison with artificial light, How does one differ from the other?

Various experts whose study of light has been

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far-reaching and comprehensive, lay down the law that the human eye is best satisfied with a light mixture corresponding to daylight, than any other combination of rays that may be produced. In other words, a comparison made between artificial light and the rays proceeding from the sun, would show the difference existing to be merely that of the various rays. For instance, there is a certain amount of red, yellow, blue, etc., in white light, or daylight; in any other artificial light, there may be an excess of either of these particular rays. In such a case, the light would necessarily be reddish, or bluish, etc., according to the preponderance of one form of light vibration over another. Now the difficulty seems to be due to the fact that in the production of light it is almost impossible to anticipate in advance what particular light mixture will be developed. Of course, if vapors of metals are involved in the experiment, some prediction can be made, because each metal has its own peculiar tinge of color when undergoing volatilization. But the mere development of incandescence in a solid body, or the production of light from particles of matter chemically unaffected when performing such a function, contains no more than a suggestion of the light mixture that will thereby result.

Daylight, as we receive it, is not the light originally produced by the sun, because of the fact that, in passing through the intervening etheric space and entering the body of the atmosphere, it is affected to such a degree that its light mixture represents a different percentage of rays from what it was before. For instance, the violet is cut down, as well as the red; and some of the other rays are reduced; the sum total delivered being what we call daylight.

It may be understood from these statements that the light mixture in what we call daylight is apt to vary throughout the day. In the morning the atmospheric density and the prevailing vapor may be different from what they will be at noon or in the evening just before darkness appears. It is evident that a cloudy day, which simply means that the sunlight is strained or in a sense filtered in passing through a great mass, in fact an ocean of air and vapor, must mean light which has not the same composition as that found under the clear sky of the Sahara Desert. What is really meant by daylight, therefore, is a clear, uniform, bright light, of no particular tinge, which is familiarly accepted and understood as a general standard of illumination. A light of this character is what the builders of artificial light sources are aiming at. The problem is necessarily one involving a contrast between daylight and the so-called artificial light. The problem is not as difficult to-day as it was twenty years ago, for the reason that more opportunities exist for the solution of it in the laboratory than ever before. In a paper read before the New York section of the Illuminating Engineering Society, Dr. E. L. Nichols made mention of the fact that in high altitudes ultra-violet rays are present in great proportion and to an injurious degree; in fact, to such an extent that dark glasses are necessary to protect the eyes.

It is obvious, therefore, that in lower altitudes the bottoms of valleys, for instance, where the aerial strata is most dense, the violet rays are so reduced that little or no evil effect follows from exposure to them. The bluish tinge has been as frequently noticed in the prevailing light of the day as the yellowish tinge, but sometimes the light effect is due to extraneous causes other than those resident in the light itself. Light falling on a yellow field produces a strong impression of yellow. On the other hand, light falling on a flower-bed of roses, produces an impression of bright red. A great deal, therefore, depends upon the light-absorbing body on which daylight or any other form of light falls.

The decorations of a room, the wall-paper, the furniture and the hangings are in themselves capable of producing an impression which will greatly strengthen the belief that the room is well lit or poorly lit; that it is bright or dark. In successful electric lighting, therefore, which means lighting with a limited source of illumination, particular attention must be paid to the character or prevailing shade of the room or hall to be lighted. Where daylight alone is concerned, plenty of windows would naturally mean plenty of light, and even though the furnishings be green or red or yellow, the impression received would be that of sufficient illumination. On the other hand, if the source of light be artificial, limited and representative of a certain percentage of light-rays, together forming the mixture the room may seem dark for the reason that certain rays may be missing from the light source, which would thereby seem to plunge certain shades of color in the room into apparent darkness. A light, for instance, minus the red rays, falling upon a surface painted red, would leave that surface looking dark, or perhaps entirely altered in tone, thus producing a confusing impression; one that would be considered entirely unsatisfactory in indoor illumination, where certain æsthetic effects are expected.

It seems as though the problem of producing light has become more and more a problem, not so

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much of quantity as of quality. The student of light effects is busily engaged at present, trying to find a source of illumination in which the rays are so related to each other, quantitatively and qualitatively, that as near an effect as possible to that which we call daylight is obtained.

Lightning Arresters

With the advancing summer season comes the need for a consideration of the means by which stations are protected against lighting and static charges. The variability in meteorological conditions in many sections of the United States, calls for considerable care and foresight in rendering the equipment immune from the destructive influence of static electricity. The fact that a lightning discharge may enter a station, unless it is either kept out or so modified if it should, perchance, enter, that little or no damage is done is obvious to even the lay mind. The popular notion that things electrical are apt to attract the lightning is not so far-fetched, in one respect at least; that conductors under satisfactory conditions do become the carriers of static charges. Those leading to the station and thus providing an inlet for the static electricity, are the ones with which science and engineering are most concerned at present.

While lightning in itself, as far as we are personally concerned, is dangerous and frequently deadly, it is not entirely because of this that electrical machinery must be protected from its destructive influences. All central station managers know that the effect of lightning in leaping from conductor to conductor, is one of the worst phases of its manifestations. In cases like this the only thing to do is to keep the lightning out, and this is really the protection which, when properly afforded, leaves the station manager's mind at rest. This is hardly the place to discuss the relative merits of the various makes of lightning arresters, except to say that none of them can sell unless it is good; and that all of them possess such features of merit that they attract interest and are the basis of sales to purchasers who believe in them.

For the benefit of those who may not be familiar with the fact, it may be stated that an ordinary static discharge may consist of one of two things: It may represent a gradual discharge diminishing in strength and intensity until it falls to zero, entirely unidirectional in character; or it may consist of a very rapid series of oscillations which flash back and forth with inconceivable rapidity, representing in some instances pulses of energy oscillating at the rate of over twenty million per second. The facts as thus established scientifically, call for an engineering solution in such a manner that whether the discharge is unidirectional or oscillatory, the station, and its machinery are amply protected. Now the fact of the matter is that the severity of the storm is not really a measure of the danger which is imminent or actually exists. A lightning discharge may be very brilliant and to the eye produce a terrific impression. Yet it may be far less dangerous in itself than the surgings or slower oscillation of large quantities of static electricity which result from conditions making themselves far less apparent.

The construction of an effective lightning arrester is therefore one involving purely technical considerations. For instance, it must meet a variety of conditions superinduced by the presence of static electricity, and be protective on all occasions. To accomplish this, its design must necessarily be based upon a full realization of the demands of science, because it is evident that the science of the thing makes the practice successful; this being the only correct foundation for engineering devices in any circumstance.

The Cost of Power

The cost of power is effective in giving rise to problems which represent much of the time, effort and money devoted to the development of central stations in the United States. So arbitrary has the problem become, that to exactly define it, means the assumption of debatable ground bearing strongly upon questions of cost of labor, depreciation, cost of fuel and general industrial conditions. It is not claimed by the representatives of central station interests in this country, that technical difficulties exist which make the operation of plants such that prohibitive rates are in any way necessary. Not that this conclusion was ever very prevalent or generally accepted as correct. But the dawn of electric lighting in America was unquestionably attended with difficulties which almost forbade hope of a speedy solution of the troubles that blocked a systematic, healthy, broad industrial development of electric light interests.

High speed and low speed plants were the problems presented; in addition to questions arising concerning the design of the generators, the pressure of the supply circuits, the use of alternating, direct or pulsating currents, and the conditions, municipal

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or otherwise local, which restricted expansion. But the cost of electric power has become settled on a rather unique basis, since that time. The design of the steam and electric sections, has reduced down to a fixed basis, in the sense that no such problem presents itself as of old. In addition to this, the station design has established itself on such rational lines, that no question could possibly arise, unless a radical change in electrical methods of generation occurred, which would disturb the general routine of practice, now so well established by custom. The lamp question is rapidly settling itself, and what were once regarded as freak types of lamps, containing in themselves only the germ of possibility as future standards, have become established and are displacing the old, generally and effectively.

The conclusion regarding the cost of power, is that for motors, the efficiency is up to the manufacturers and not the central station men. Otherwise the form of contract for power is largely a question of the quantity consumed, and the time of the day it is to be utilized. On the other hand, the higher efficiency of lamps has placed the cost of power for lighting on such a basis that complaints on this score would be easily removed by a little lesson on the conditions which now exist and which speak so promisingly of the future of electric lighting.

In certain sections of this country, in spite of every effort made, the cost of power remains high and causes argument in many cases. Now it is well known, that what is called the cost of power, is entirely dependent upon the cost of producing it. It is also well known that the cost of producing power is not the same in localities with good natural resources as those without.

In consequence of this, with the fact accepted, that power charges are high, the question of what is the best thing to do is the most practical to consider. Where a motor is used, its horse-power means a certain amount of electricity at a certain cost per unit of energy. This is a charge that can hardly be varied, except by a form of contract with the central station, that makes it pay the best it can under the circumstances. But the introduction of lamps of the metallized-filament, tungsten and tantalum type, helps to a reduction in cost of lighting, which in this particular phase of central station service at least, means a reduction of the cost of lighting down to its lowest terms.

The other question, aside from that of lighting itself, which bears directly on the service during the day, is the time of the heaviest and the lightest load. In many instances it is not only possible, but it actually happens, that the day load is of no consequence whatever, and the plant is practically idle during this period. The use to which the plant is put is only a few hours at night, and while this makes it pay to run the plant, it raises the average cost of power, on account of the enforced idleness to a comparatively high point.

The cost of power is therefore best understood with reference to the conditions of service during the day. It is always unfortunate when a large equipment like a modern electric light plant is forced to have limitations put upon its earning power during the greater part of the twenty-four hours, simply because industrial propositions have not materialized as they should in that vicinity. In many instances, the directors of a plant could be influential in transplanting or creating industries in the vicinity, which would make the day load sufficiently heavy to net a profit, and thus assist the enterprise to be more of a success.

By examination of external conditions, and the relationship between them and operating conditions, the cost of power, the paying of dividends, and the general success of the plant as a whole can be much better understood.

Last Year's Turbine Business

Retrospective of the development during the past year of the steam turbine, the accompanying figures reported by the Westinghouse Machine Company are interesting as tending to controvert the general impression that the turbine business suffered heavily during the year. Although one month's business in 1906 stil holds the record at 62,100 kw., the year 1907 was marked by an average demand quite as large. As late as July, orders for 34,750 kw. were taken during that month as compared with 25,750 for July, 1906, which is a particularly gratifying showing. For the first nine months of each year the demand for turbines was as follows: 1907, 158,550 kw., and for 1906, 152,400 kw. Or, taking the middle six months of the year, from April to September inclusive, thus excluding the usual midwinter activity, as well as the late depression, the average per month is as follows: 1907, 15,833 kw.; 1906, 14,365 kw. Thus it is apparent that up to the period immediately preceding the depression of October, the demand for turbine equipment shows a steady increase. It is interesting to note in this connection, the ultimate results of commercial activity of the past few years.

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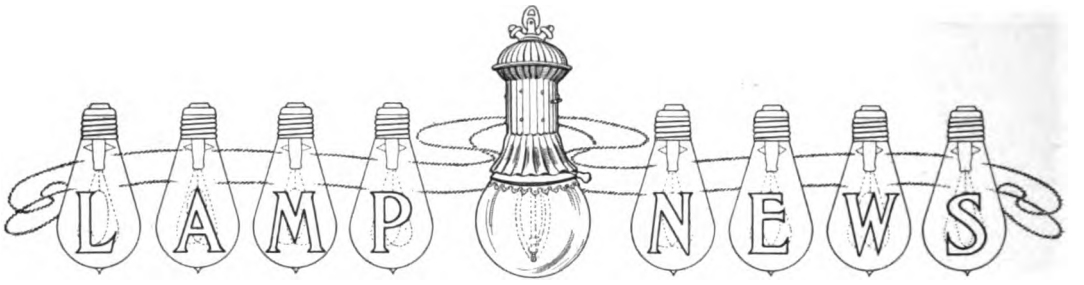

Mr. J. W. Lieb, of the New York Edison Company, states that his company is to reduce the price of Tantalum lamps from thirty-five to twenty-five cents each, with certain renewal privileges: Tungsten lamps of 32-c.p., 40 watts, will be furnished for one dollar; the 60 watt, 48-c.p. Tungsten lamp for $1.25, and the 80-c.p., 110-watt lamp at $1.50. It is the intention of the company to place these Tungsten lamps in the customer's sockets, and will demonstrate that each lamp is in good condition before the customer is required to pay for same. Following is the schedule which was handed by Mr. Lieb to the Public Service Commission:

PRICE OF INCANDESCENT LAMPS.

Cp.	Type.	Watts.	Prevailing retail price. Plain.	Frosted.	Extra price charged to renewal customers.
16	Carbon	50	$0.20	..	Free renewal
32	Carbon	100	.30	..	Free renewal
20	Gem	50	.25	..	Free renewal
20	Tantalum	40	.60	$0.62½	25c. or 27c.
25	Tantalum	50	.60	.62½	25c. or 27c.
32	Tungsten	40	1.50	1.55	$1.00
48	Tungsten	60	1.75	1.82	1.25
80	Tungsten	100	2.00	2.10	1.50

Mr. Lieb further stated that, while the above list covers the Tungsten lamps now on the market, in a short time Tungsten lamps of less than 32 candlepower would probably be on the market, and that the customers of the New York Edison Company would receive the benefit of same, as well as the decrease in prices which are bound to ensue with the increased manufacture of this type of lamp. Mr. Lieb also submitted to the commissioner the following table, which makes clear the relative status of the several types of lamps:

COST TO CUSTOMER OF 10,000 CANDLE-HOURS OF ILLUMINATION.

Cp. of lamp.	Type. of lamp.	Watts.	Cost of lamp.	Kw-hours of current consumed.	Current cost.	Lamp cost.	Total cost.
16	Carbon	50	Free renewal	31.25	$3.12	$0.000	$3.12
20	Gem	50	Free renewal	25.00	2.50	0.000	2.50
25	Tantalum	50	Extra 25c.	20.00	2.00	0.125	2.125
32	Carbon	100	Free renewal	31.25	3.12	0.000	3.12
32	Tungsten	40	Extra $1.00	12.50	1.25	0.312	1.562

The General Electric Company has obtained very satisfactory results with the Tungsten lamp. They have shipped over 75,000 to all parts of the country and the breakage in shipment is below one and one-half per cent. They state that they are issuing a new bulletin covering Tungsten lamps, both series and multiple, and have a large production, good stocks and are in position to make prompt shipments, particularly of the 100 watt and all types of Tungsten lamps which they have standardized.

Tantalum wire is now being used in electric lamps, and according to a French patent recently issued, G. C. Bouhard makes it by electro-deposition in the following manner:

To 100 parts of potassium tantalate dissolved in 3,000 parts of water, sulphuric acid is added until no further precipitate is formed. After several hours the precipitate is filtered, washed and mixed with 1,000 parts of water heated to about 150 degrees F. A 5 per cent. solution of oxalic acid is now added, and the precipitate dissolved.

The excess of ammonia is now neutralized by ammonia, and the 3 per cent. of either sulphuric acid or muriatic acid is added. The solution is then used for depositing the platinum.

A carbon or platinum anode is used, and for the cathode some horizontal platinum or carbon wires are employed. The tantalum is deposited with a current of two volts. When the metal has attained a sufficient thickness, it is drawn into wire and used for incandescent filaments. Niobium may be made in the same manner.

Judge Buffington, in the United States Circuit Court in Pittsburg, on May 14 decided that the Edison patent on leading-in wires for incandescent lamps which several years ago figured so largely in incandescent lamp litigation, was invalid.

This patent related to the use of a small length of platinum wire entirely sealed in the glass, to which are soldered outer and inner leading-in copper wires.

In the earlier days the entire length of the wire between the filament and the socket was of platinum, whereas, by the means described in the patent, the length of platinum wire is reduced to about a

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quarter of an inch for each side of the leading-in circuit.

Judge Buffington held that the location of the Edison joint was but a mechanical improvement. "He did not discover a copper-platinum joint could be made in a seal without destroying its integrity, but by correcting a false notion as to the effect of such a seal at its other end, he broadened the sphere of use of such seal. It was one of those mechanical advances which the increastd cost of platinum and closer study of manufacturing problems naturally brought about." The patent was thus declared void.

The suit in question was brought by the Edison Electric Light Company against the Novelty Incandescent Lamp Company, of Emporium, Pa. As the patent above referred to expired in January, the effect of the recent decision will simply preclude the recovery of damages in this and other similar suits pending.

There has just been placed on the market by the General Electric Company a new flame arc lamp. The external appearance of this lamp is similar to the G. I. enclosed lamp, the casing being drawn seamless from either sheet copper or steel. The standard finish for the copper casing is "Antique" and "Bright Japan" for the steel. This lamp has no chain feed or complicated escapement and clock mechanism. It is of the inclined carbon type with nothing below the arc to obstruct the light, and both carbons feed by gravity simultaneously while the regulation of the arc is accomplished by the lateral movement of one carbon to the other. When the casing is lowered into the trimming position every part of the lamp becomes accessible,

A serviceable "economizer" of refractory material surrounds the points of the carbon just above the arc so as to prevent the "washing" of the carbon ends, and to steady the arc from the effect of air currents so far as possible. A "blow magnet" is so situated with relation to the arc that it performs the double function of keeping the arc steadily fan-shaped at the carbon tips, and also totally extinguishes the arc if for any reason it approaches dangerously near to the "economizer." The "economizer," therefore, is well protected from burn out and should last indefinitely. A heavy "baffle plate" of insulating material is provided just above the "economizer," effectually preventing any appreciable amount of the products of the arc from depositing on the parts of the mechanism. During operation the lower surface of the bottom plate of the lamp and of the economizer becomes coated with white deposit from the arc which acts as an excellent reflector for the upward light from the arc.

These lamps ars designed to burn two-in-series or singly across 100 to 125 volt direct or alternating current circuits. They can be used on any frequency between 40 and 140 cycles. The lamps may be wound for either 8, 10 or 12 amperes, the latter current being considered standard. All lamps are equipped with light opal globes.

The life of these lamps is about twelve hours on indoor circuits and between 10 and 11 hours on outdoor circuits. The simple construction, remarkably high efficiency, and the volume of illumination obtained from these lamps appeal to the operators of mills, wharves, warehouses, erecting shops, foundries and other places where the quantity of light is as desirable as the quality.

During the past few years a great deal of attention has been paid both by chemists and electrical engineers to the construction of metallic-filament lamps for incandescent electric lighting. Ever since the advent of the Nernst lamp with its oxide-filament, chemists, scientists, and lamp makers have felt instinctively that the supremacy of the carbon-filament lamp was seriously challenged. The efforts made have been attended with more or less success, yet it may be news to a large number of electrical engineers of the younger generation that the metallic-filament lamp is one of the oldest forms of electric lighting. In fact, incandescent electric lighting commenced with metallic-filament lamps, platinum being the incandescent body. Such lamps were made long before the Edison or the Swan carbon-filaments were invented. Several inventors worked on these lines, and Edison especially endeavored to perfect a lamp in which a thin platinum wire raised to white heat by the current formed the illuminating body.

These lamps were, however, never a commercial success, because the melting-point of platinum is only slightly higher than that temperature to which it has to be raised for the economical production of light. In consequence the life of the filaments was short, and the slightest increase in the voltage, which was extremely difficult to prevent in those days, was sufficient to melt the filament. Attempts were made to overcome this defect by automatic arrangements to cut out the lamps should the voltage rise to a point likely to melt the filament.

Even in 1880 we find Edison trying to further im-

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prove the platinum lamp. Maxim in 1881 describes and claims a thermo-regulator designed to prevent the overheating and consequent melting of the platinum filament. In the same year Maxim described a process of producing carbon bodies for illuminating purposes which were flashed in carbonaceous vapors with a view of improving them.

It was in 1881 that the carbon-filament lamp came to the front and stopped the researches and experiments in connection with the perfection of the then existing metallic-filament lamps. It was only after a lapse of nine years that the next American patent dealing with a new metallic-filament lamp made its appearance—this was the Poland patent No. 432,-710, of 1890, for the iridium lamp.

There were two predominant reasons for the immediate success of carbon as a glow-lamp filament.

1. It could not be melted, and in this respect had an enormous advantage over any of the then known metals. Platinum had at that time the highest melting-point of any of the then available metals which could be made into a thin wire, but this temperature is much lower than that which a carbon-filament will stand for a prolonged period in a vacuum.

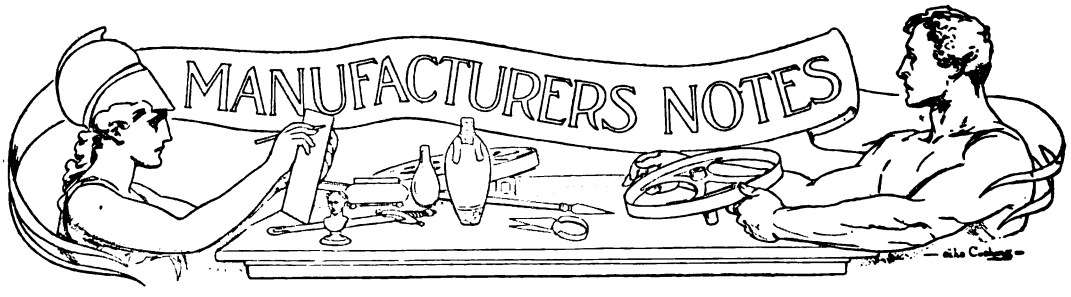
2. Carbon has also a very high specific resistance as compared with any of the metals then available. The question of the distribution of current was at that time of great importance, and it was even then recognized to be a difficult problem to distribute large currents at a low pressure over a considerable area.

Due to its high specific resistance carbon was found to be a most suitable material from which to produce illuminating bodies to be incandesced by a small current at a high voltage.

When first introduced the carbon-filament lamps were made for circuits of 50 to 60 volts, but improvements in manufacture soon increased the standard to 110 volts. The bulk of the pioneering work in central station supply was carried out at this voltage, but it was found that as the distribution networks were extended over large areas the great cost of attaining constant voltage was hampering the spread of electric lighting. The mains absorbed such a large proportion of the total capital outlay of a supply system that it was found necessary to raise the pressure of distribution in order to keep down the cost of electrical energy to a reasonable figure.

The 3 and 5-wire continuous-current systems invented by the late Dr. John Hopkinson, and the high-pressure alternate current with step-down transformers, helped to extend the period during which 110-volt lamps could be used. In spite of these means of reducing the cost of the distributing networks and feeders, the engineers of the electric supply companies and of the municipal authorities encouraged the incandescent lamp makers to develop higher voltage lamps. As a result the 200-250-volt lamps made their appearance in the early nineties, and by the middle of that decade were adopted commercially.

Although these lamps were not as efficient as those for the lower voltages, they saved so much in the cost of distribution that the supply companies were able to reduce the cost of electrical energy to those consumers using them. These lamps have since been so far improved in efficiency as to meet all requirements, and they were officially recognized by the Board of Trade Regulations issued in 1901, which enabled the supply undertakers to enforce their use on all consumers.



At the Convention

Mr. Hugo Reisinger, sole importer of the famous Electra carbons, unquestionably the finest made in the world for enclosed arc lamps, was represented at the convention by his right-hand man, Mr. DuBosch, of the New York office, and by Mr. Kenny, his western representative.

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The Chicago Fuse Wire and Manufacturing Company made a fine exhibit, which was in charge of the Messrs. Merrill.

The Holophane Company was represented by Mr. Van Rensselaer Lansingh, of the New York office, and Mr. H. D. Howe, western manager.

The interests of the Economical Electric Lamp Company, of New York City, manufacturers of the Economical Turn-Down lamps, were looked after by Mr. M. Lobenthal.

The American Electrical Works, of Providence, R. I., were represented by Mr. Donohue, manager of the New York office, and Mr. Hammond, manager of the Chicago office.

Mr. B. J. Tremaine and Mr. F. S. Terry, of the National Lamp Company were among the first and last at the convention.

The Chase-Shawmut Company, of Newburyport, Mass., whose enclosed fuses have become standard in central station practice, was represented at the convention by sales manager, Mr. H. P. Moore.

The Okonite Company was represented by its general superintendent, Mr. George T. Manson, of the New York office.

The American Circular Loom Company was represented by Mr. Thomas G. Grier, who had with him his large staff of assistants.

Mr. D. J. Burns, sales manager of the Ward Leonard Electric Company, of Bronxville, N. Y., exhibited for his company its new meter-testing rheostat, which created a great deal of interest and favorable comment.

The Adams-Bagnall Electric Company, of Cleveland, Ohio, manufacturers of the famous arc lamp of that name, were represented by Mr. Worbs and Mr. Pomeroy, of the Chicago office.

Mr. G. M. Gest, expert electrical subway contractor of New York and Cincinnati, was represented by one of his engineers, Mr. W. T. Jackson, and Mr. J. A. Doyle, of Chicago.

The Crescent Company, of Valparaiso, Ind., was represented by Mr. J. H. McGill, president of the company, and Mr. A. O. Einstein, general sales manager.

President Arthur C. Garrison, of the Columbia Incandescent Lamp Company, accompanied by Mr. Vincent Gray and Mr. J. B. Coale, was on hand during the entire convention.

Mr. Ernest Haughton, western manager of the Bryan-Marsh Company, was, of course, on hand during the entire convention. Judging from the business that this hustling young manager has corralled in Chicago, his connection as western manager of the Bryan-Marsh Company has been one continuous convention of his own.

The John A. Roebling's Sons' Company, of Trenton, N. J., was ably represented throughout the entire convention by Mr. Conover, western manager of the company.

The Buckeye Electric Company, of Cleveland, Ohio, was represented during the convention by Mr. L. P. Sawyer, who was accompanied by Mrs. Sawyer, acknowledged to be one of the most beautiful girls in Cleveland. To use "Sorry's" expression, "that's going some."

Dossert and Company, of New York City, manufacturers of the Dossert solderless connecters, cable taps and terminal lugs for electric cables and solid wires, had a most interesting exhibit. The fact that these connecters are the only ones approved by the National Board of Fire Underwriters, and the additional fact that these joints are being universally used in all high class installations and central station work, made this booth one of the most interesting in the Exhibition Hall. The exhibit was in charge of President H. B. Logan, assisted by his mechanical engineer, Mr. Charles A. Flynn.

The Conduit Electrical Manufacturing Company, of Boston, had a most interesting exhibit of its oil-switch and circuit-breakers. In the absence of Mr. S. B. Conduit, Jr., the president of the company, the exhibit was in charge of Mr. William Taussig and Mr. Fred R. Babcock, the Chicago representatives, together with Mr. P. R. Fisher, general manager of sales.

The Colonial Electric Company, of Warren, Ohio, was represented by Mr. J. B. Estabrook, general manager of sales.

Mr. N. L. Norris, general manager of the Banner Electric Company, of Youngstown, Ohio, was on hand during the entire convention.

One of the most interesting exhibits at the convention was that of the Simplex Electric Heating Company, of Cambridge, Mass., which, under the direction of General Manager James I. Ayer, does

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nothing half-way, and their very complete line of heating and cooking apparatus created a great deal of attention and most favorable comment. Mr. James I. Ayer is one of the veterans of the National Electric Light Association, and one of its earlier presidents.

Mr. Ayer, was assisted by Mr. Roger Williams, of the New York office, and Mr. H. R. Hixson, manager of the Chicago office, assisted by Mr. E. R. Jacobs.

The American District Steam Company, of Lockport, N. Y., made a very comprehensive exhibit of every detail of the operation of their system of district steam heating from both live and exhaust steam from central stations, the company being represented by Mr. Robert Hall, treasurer, assisted by Mr. H. C. Eddy, of the Chicago office.

B. S. Barnard & Company, of New York and Chicago, was represented by Vice-President E. F. Kirkpatrick. This new company, of which Captain B. S. Barnard, so well known in the underground vitrified conduit industry, is president, has made a tremendous success in Chicago during the past few months, among other large contracts having secured a large share of the Chicago street railway business.

The Excello Arc Lamp Company, of New York City, was represented by President Hirschberg, assisted by his western manager, Mr. Armstrong and Mr. H. W. Fowzer. The exhibit of Excello arc lamps in front of the Auditorium Hotel was one of the most attractive, as well as convincing demonstrations as to the quality and steadiness of the Excello lamp, which is now being ordered by central stations in thousands for the use of their customers.

The Weston Electrical Instrument Company, of Newark, N. J., was represented by Mr. F. B. Badt, who is western sales agent.

The Engineering Department of the National Electric Lamp Association occupied one of the largest spaces in the exhibition hall, their booth being beautifully decorated. Tungsten and tantalum lamps, with Holophane reflectors, were shown. Although the 100, 60 and 40-watt sizes of Tungsten lamps were exhibited, the lamp which made the "hit" was the new 25-watt, 20 c.p., 100 to 125 volt Tungsten lamp, which made its first appearance at this convention. A new type of 25-watt, 12½-c.p., 100 to 125 volt Tantalum lamp also made its first appearance at this convention, at the exhibit of the National Electric Lamp Association, and together with the baby Tungsten, like all interesting infants, created a great deal of attention from the central station managers. This exhibit was in charge of Mr. S. E. Doane, chief engineer of the association, around whom were assembled all the "boy managers" or "young bloods," to be more accurate, of the Lamp Association.

General Electric Company, as usual, made its dignified and comprehensive exhibit, including its new type of luminous radiator, as well as its interior and outdoor luminous and flame arc lamps. Their new aluminum-cell lightning arrester, which is creating so much attention among central stations, was also exhibited, as well as a very complete line of meters of both the portable and stationary types. Samples of their small motors for both alternating and direct currents were also shown, and a continuous demonstration of General Electric cooking devices was made. The representatives of the company were: Mr. J. R. Lovejoy, Mr. Caryl B. Haskins, Mr. E. W. Rice, Jr., Mr. P. D. Wagoner, Dr. C P. Steinmetz, Mr J. W. Kirkland, Mr. F. H. Gale, manager of the Publicity Department of the company, Mr. A. D. Page, of the Edison Lamp Works, Mr. C. B. Burleigh, of the Boston, office, Mr. W. D'A. Ryan, and many of their district managers from all parts of the country. Many of the most interesting and instructive papers presented at this convention were by the representatives of the General Electric Company.

The exhibit of the Westinghouse companies was at the entrance of the Exhibition Hall, and was given up principally to the exhibition of a line of their small motors, detail apparatus, measuring instruments and lamps. A complete line of incandescent lamps, manufactured by the Westinghouse Lamp Company, was shown, as was also the new Westinghouse metallic flame arc lamp. The exhibit of this company was constantly thronged by central station men from all over the country. As usual, the exhibit was ably arranged and managed by Mr. J. C. McQuiston, manager of the Westinghouse Companies' Publishing Department, assisted by Mr. J. O. Lytle. Among the various heads of the various departments of the Westinghouse Companies, were Mr. Thomas G. Whaling, Assistant General Manager of the Westinghouse Lamp Company; Mr. C. S. Cook, Manager of the Railway and Lighting Sales Department; Mr. C. B. Humphrey, Manager of the Detail and Supply Departments; Mr. S. L. Nicholson, Manager of the Industrial and

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Power Sales Department; Mr. Charles Robbins, Commercial Engineer of the Industrial and Power Department, and Mr. H. B. Davis, Assistant Engineer. There were also present Mr. T. P. Gaylord, Chicago Manager; Mr. C. F. Medbury, Detroit Manager; Mr. J. A. Brett, Cincinnati Manager; Mr. G. E. Miller, Cleveland Manager, and Mr. W. R. Pinckard, of the Chicago office.

The Westinghouse Machine Company was represented by Mr. E. H. Sniffen, Mr. C. C. Chappell and Mr. J. R. Bibbins. The Storage Battery Department of the company was represented by Mr. C. L. Davis.

The Nernst Lamp Company was represented by Mr. Max Harris, General Manager of Sales; Mr. W. P. Uptegraff, Vice-President of the company, and by Mr. Otto Foell, Chief Engineer.

Allis-Chalmers Company, of Milwaukee, made a very interesting exhibit which was in charge of Mr. C. A. Tupper, Manager of the Publicity Department. Mr. W. H. Whiteside, President of the company, spent several days at the convention, and was accompanied by Mr. A. H. Whiteside, the Manager of the company's electrical and steam departments. Mr. B. A. Behrend, Chief Electrical Engineer of the company, was also present, accompanied by a large force of his engineering staff. Mr. L. M. Harvey, Manager of the Sales Department in Milwaukee, and Mr. James W. Gardiner, Manager of the Chicago office, were also present during the convention.

One of the exhibits of the Allis-Chalmers Company which created a great deal of attention was a board containing a complete line of blades and foundation rings from an Allis-Chalmers steam turbine, designed for direct connection to 1,500 kw. Allis-Chalmers generator. The company also showed a number of its latest type induction motors, and type K motors for direct current, as well as a line of their new type of transformers. As in previous exhibitions, the Allis-Chalmers Company showed a most interesting collection of framed pictures of their standard types of prime movers and other apparatus built at their enormous West Allis works.

Everybody complimented Mr. C. A. Tupper, manager of the Publicity Department of the Allis-Chalmers Company, of Milwaukee, on the masterly manner in which he took charge of all the incoming and outgoing shipments of the exhibitors during the convention. Mr. Tupper had with him a force of his own men from the factory, and everything was handled in an "Allis-Chalmers" manner.

Late Allis-Chalmers Turbine Contracts

In addition to the shipment of eight Allis-Chalmers turbine units from the West Allis Works within the past week to various commercial centers of the East and South, two contracts for turbine-generator units, each 500 kw. in capacity were received, one from Texas and one from Washington.

The first unit was purchased by the city of Austin, Texas, and is a 2,300 volt, 600 cycle, 3 phase machine designed to operate condensing. The second unit will be installed by the Salsich Lumber Company, of McKenna, Wash. This unit is a 400 volt, 60 cycle, 3 phase machine, the steam end of which is also designed to be run condensing. In addition the purchase includes an 80 kw. alternating current generator driven by a Chandler & Taylor engine; a 15 kw. steam driven, and a 15 kw. motor driven exciter set; a four panel switchboard; a 20 h.p. induction motor for driving a centrifugal pump and two 15 h.p. induction motors.

The exciters are each of sufficient capacity to excite both the 500 and the 80 kw. generators. The steam driven unit comprises a 15 kw. 120 volt compound-wound direct current generator direct connected and on the same bed plate with a double cylinder, direct acting, American Blower Company's engine. The motor driven exciter comprises a 15 kw., 120 volt compound wound direct current, type "K" generator, direct connected to a 3 phase, 60 cycle, 440 volt induction motor.

Allis-Chalmers Company has opened an office at Birmingham, Alabama, in charge of Mr. Seldon Jones, as district manager, Rooms 319-320 First National Bank Building. Inquiries regarding the varied lines of machinery manufactured by the company will be promptly attended to at this address.

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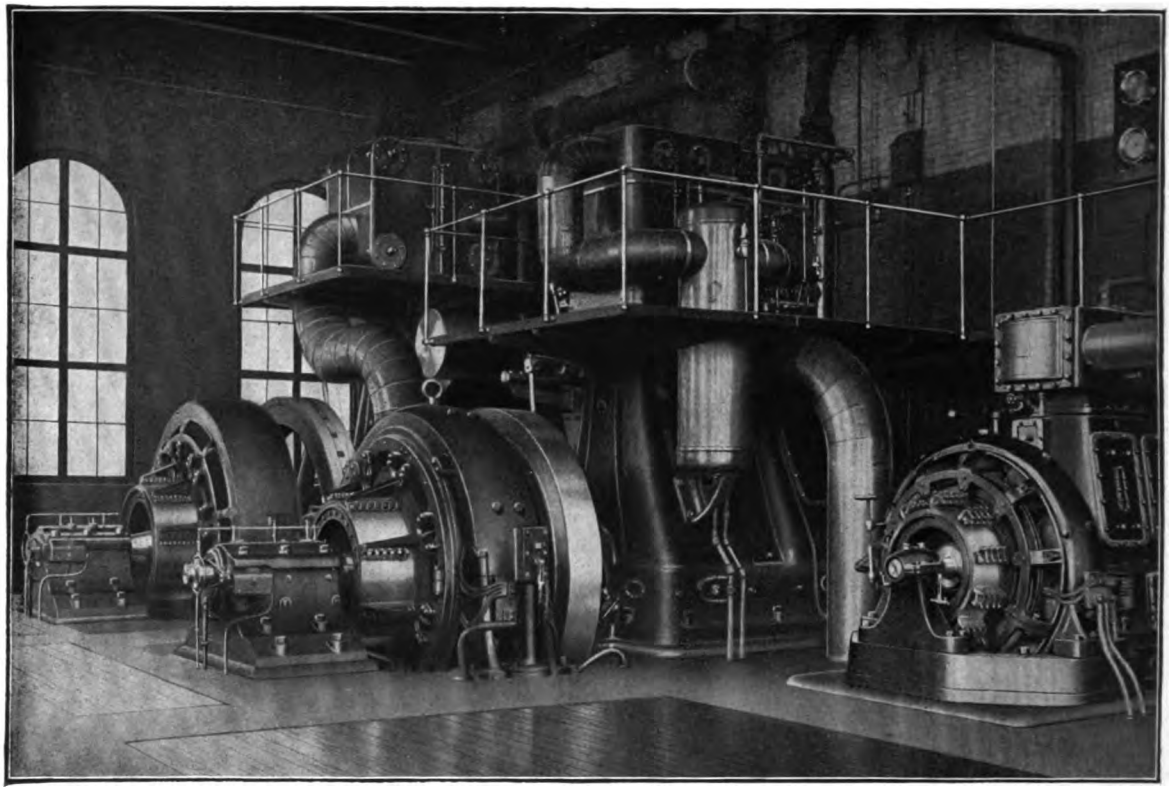
Generating Sets with Compound Engines

While it is true that the economy of a power plant depends upon the efficiency of the boilers, furnaces, draft, economizers, etc., the economy of the engine itself is the factor that determines the amount of fuel that must be purchased. With the same efficiency of boilers, etc., a compound condensing engine will effect a saving of from 20 to 40 per cent. over a single cylinder engine, the amount of saving depending, of course, upon the conditions, the form of valve gear, the speed, etc. The installation of the compound engine should be a matter of careful consideration and calculation. While it is a fact that in some localities fuel is very cheap, there are not many places where the cost of fuel is so low that it does not pay to install a compound engine. As a rule the compound engine will not only pay good interest on the additional cost, but will also in a short time pay the additional cost itself. Another feature to be noted in connection with the compounding is the relative cost of equipment for steam generation. Since the compound engine uses much less steam, the boilers, pumps, etc., may be correspondingly smaller.

For many years the B. F. Sturtevant Company, of Boston, Mass., has been making small generating sets in such sizes that prevent the attainment of great economy. The larger sizes now being placed upon the market by this company, that is, 150 to 500 kw. generating sets with compound engines, admit of devices for saving steam. The engines of these sets are of the four-valve type in order that the events of the stroke may be separately adjusted and the clearances reduced to a minimum. Gridiron valves are used to get the advantages of this type. The valves are placed horizontally in chambers provided for the purpose in the cylinder castings, both the ports and the valves being removable and of the gridiron type. Upon the face of each steam valve slides an auxilary gridiron valve, which being connected to the governor, controls the cut-off. The exhaust valves and the main valves are actuated by the eccentric on the shaft, the proper motion being given by levers and rockers. Upon the high-pressure side of the engine a modified Rites' governor is placed in the regulating wheel, while a larger flywheel is placed upon the shaft at the generator end.



INSTALLATION SHOWING THREE STURTEVANT GENERATING SETS.
100 K.W., 250 K.W., AND 400 K.W.

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In addition to the advantages as regards economy, the Sturtevant generating set is designed for continuous operation with little or no attention. To accomplish this, all moving parts, except some portions of the valve gear, are entirely enclosed, and watershed partitions, placed between the frame and the lower cylinder heads, prevent water from the stuffing boxes mingling with the oil in the frame, and also making it impossible for oil within the frame to enter the cylinder on the piston rod. All wearing surfaces within the frame are supplied with an abundance of oil by means of a system of forced lubrication. With this system a small direct-acting pump forces oil through passages in the moving parts and through small pipes to the crank pin, wrist pin, cross-head guides, etc. The same system supplies the outboard bearing.

The generators are of the Sturtevant ten-pole type direct-connected to the engine shafts by a flange coupling. They are designed for a wide range of load, and require little or no attention. Ample cooling surfaces and mechanical ventilation render the generators free from heating and burnouts. These machines are capable of carrying an overload of 33 1/3 per cent. for two hours without injurious sparking, and an overload of 100 per cent. momentarily without destructive sparking or heating. The insulation will not deteriorate after continuous operation at normal temperature. At maximum temperature, the insulation resistance between the windings and the frame is tested at alternating pressure of at least 1,500 volts at 60 cycles for a period of 60 seconds.

The armature is of the iron-clad, drum-wound type, the core being built up of sheet steel segments, clamped between end flanges and provided with vanes which maintain a constant blast of air over the surfaces of the winding. The armature is multiple-wound and provided with cross-connecting rings, so that all brushes of the same polarity are maintained at the same potential, a feature that insures a uniform pole strength.

The commutator, mounted on an extension of the armature, is built up of drawn copper segments, which are insulated with amber mica of the best quality, of a thickness that makes impossible an accidental breakdown. So perfect is the commutation of these generators that the necessity of turning off the commutator is a very remote possibility.

Carbon brushes of a size that the current density will never exceed thirty amperes per square inch, are held in the latest design of sliding-socket shunt brush holders, which are clamped on a composition frame, insulated from the brush ring itself. Each brush holder can be adjusted separately and removed for cleaning and repairs, or the entire brush ring may be rotated by a hand wheel.

New Use for Manganese Steel

A good example of how the development of one industry helps another, is found in an order for manganese steel discs recently placed by the Cutler-Hammer Clutch Co., of Milwaukee. This company, in addition to manufacturing magnetic clutches, makes a specialty of lifting magnets for handling pig iron, and scrap metal. The growth of this latter business and the natural desire of the manufacturers to perfect every detail of their product has led to the adoption of manganese steel for coil shields—the coil shield being the flat disk fastened to the under side of the lifting magnet for the double purpose of protecting the magnetizing coil and interposing between the two poles of the magnet an area of non-magnetic material. Brass, which is non-magnetic, has heretofore been used for this purpose. Ordinary steel will not do because it is a magnetic metal and would serve to conduct the magnetic lines of force from pole to pole instead of compelling them to seek a passage through the material to be lifted. Manganese steel seems to be the ideal metal for this purpose. It is non-magnetic, like brass, and infinitely harder—so hard, in fact, that the continued hammering of the pig iron or other metal on the under surface of the magnet makes not the slightest impression on it. The 50-inch magnets recently furnished by the Cutler-Hammer Clutch Co. to a number of steel mills in the Pittsburg district are all equipped with manganese steel coil shields instead of with the brass coil shields formerly used.

Aluminum Cell Lightning Arresters

There has just been placed on the market by the General Electric Company a form of electrolytic lightning arrester known as the aluminum cell arrester for operation on alternating current circuits. The arrester, as shown in Figure 1, consists essentially of a series of concentric inverted cones placed one above the other with a vertical spacing of about 3/16 inch. The cones are insulated from each other except for the electrolyte which partially fills them. Each cell then consists of two aluminum cones and the intervening electrolyte.

A sufficient number of cells placed in series form

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a complete arrester, the electrical characteristics of which are the same as a single cell. The cones complete with the electrolyte are immersed in a tank of oil which affords the necessary insulation and great heat absorbing capacity. These tanks are made of welded steel and are equipped with wooden covers and suitable porcelain bushings.

The efficacy of the cones as a lightning arrester depends upon a thin film which is formed upon the surface of the aluminum by a special process of manufacture. This film may be compared with the safety valve of a steam boiler which opens at a definite pressure and allows the steam to escape.

Each cell, two adjacent cones with intervening electrolyte, is designed to operate normally at 300 volts. If the potential rises to any value greater than 300 volts and less than 420 volts, the film allows the discharge to take place, but a thicker film is immediately formed and the current is again decreased to a small value. When the line potential becomes normal this extra thickenss of film gradually dissolves, leaving the film in its normal condition.

At 420 volts (about 40% above normal voltage) the film opens and allows a free and heavy discharge to take place. This voltage represents the maximum critical film value per cell. The plate area of the cells is sufficient to allow a discharge of more than 1,000 amperes at double normal potential, or 600 volts per cell. This represents a quantity of electricity many times greater than that usually liberated by an ordinary induced lightning stroke. Consequently it is not possible to get an excessive potential across the terminals of the arrester by such discharges.

The aluminum cell arrester is designed to be connected to the line through adjustable horn gaps. These gaps may be set so that the voltage will break across at any desired rise above the normal operating voltage. When the conditions warrant the gaps can be set so as to allow the arrester to discharge when the line voltage rises only about 25 per cent.

The horn gaps perform three important functions: 1st, they act as spark gaps as explained; 2nd, they may be used as disconnecting switches, and third for subjecting the arrester to normal voltage. It is recommended that current be sent through the arrester every day or two, so as to assure proper formation of the film on the aluminum cones. The horn gaps are so constructed that they can be easily short circuited momentarily for accomplishng their purposes.

In General Electric aluminum cell arresters for alternating current circuits the use of steel for the containing tank prevents liability of breaking during transportation, installation or operation.

Another important feature in the mechanical construction of these arresters is that the aluminum cones are supported by their rim at four points; thus making a sturdy construction and eliminating any liability of the adjacent cones short circuiting against each other.

The cone shape, or pointed construction of the aluminum, used in this type of arrester, has no horizontal film surface, thus preventing the accumulation of small globules of gases which destroy the film; cause local heating in the aluminum and materially shorten the life of the arresters.

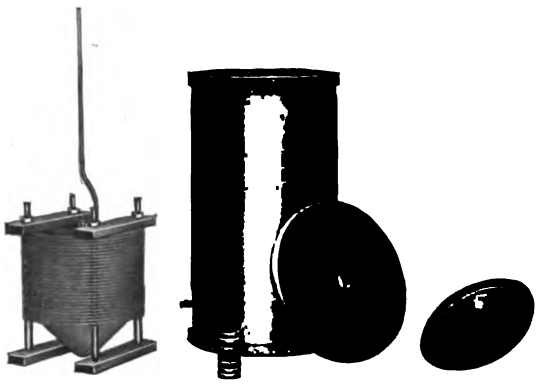

FIG. I.—ALUMINUM CELL LIGHTNING ARRESTER.

Some of the advantages of this type of arrester, from a protective standpoint of view are as follows:

1st. They are designed to discharge at a comparatively small rise of voltage.

2nd. The arrester will discharge the heaviest induced stroke without allowing an abnormal rise of voltage in the system.

3rd. The large amount of oil used for heat absorbing and radiating capacity enable the arrester to discharge continuously for a half hour. This is particularly desirable in case of a grounded phase, since the cause of the ground can often be located in a half hour's time, or necessary switching done so as to transfer to another set of busses.

4th. An inherent feature of General Electric aluminum cell arresters with a properly formed film is the fact that no dynamic current will flow as a result of the discharge.

4-4

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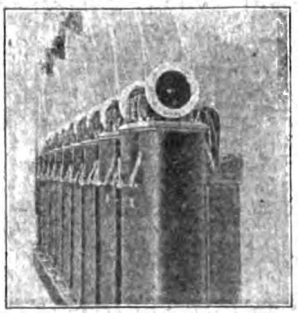
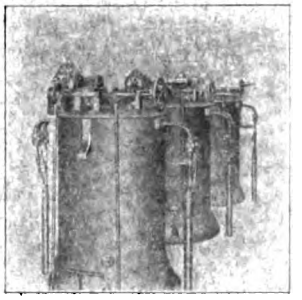
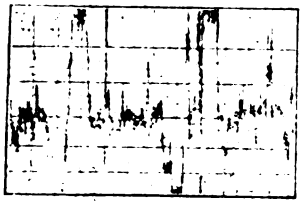


Type B R Feeder Regulators for rapid fluctuations.



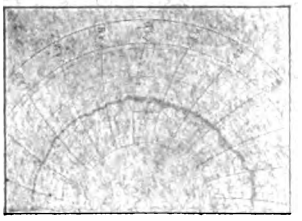
Type I R T Voltage Regulators for three-phase feeders.



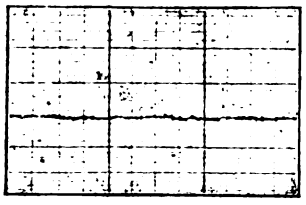
Without Type T A Regulator.

Without Type I R S Regulator.

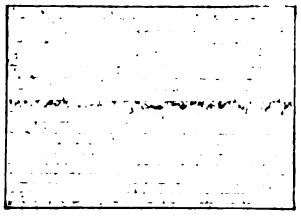
Without Type B R Regulator.



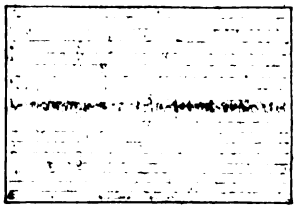
Without Type I R T Regulator.



With Type T A Regulator



With Type I R S Regulator.



With Type B R Regulator.

With Type I R T Regulator.

1337

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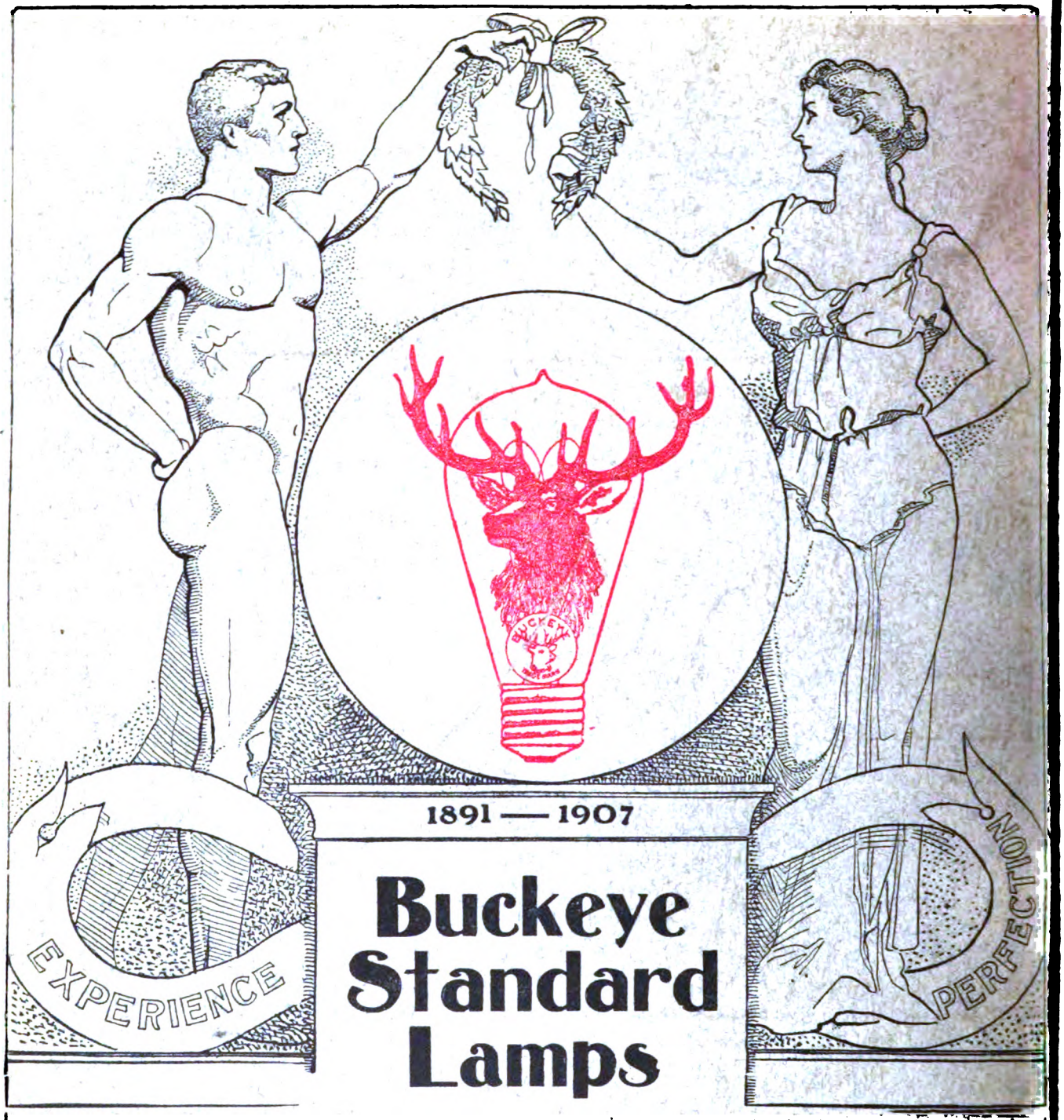

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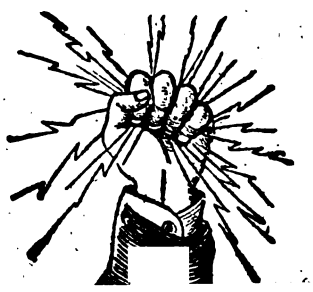

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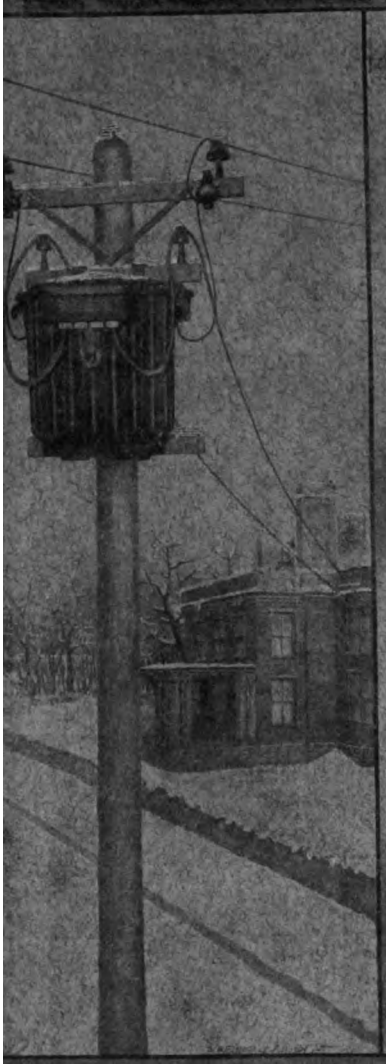

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The Westinghouse Electric & Mfg. Co. makes an equally complete line of Oil and Water Cooled Transformers of large capacities, for long distance power transmission lines up to and above 115,000 volts.

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N. E. L. A. CONVENTION REPORT NUMBER

The Central Station

DEVOTED EXCLUSIVELY TO THE INTERESTS OF ELECTRIC LIGHTING AND POWER STATIONS

Vol. 7. No. 12. JUNE, 1908. One Dollar a Year.

1889
PARIS EXPOSITION MEDAL
FOR
RUBBER INSULATION.

OKONITE
TRADE MARK
REG. U.S. PAT. OFFICE.

1893.
WORLD'S FAIR MEDAL
FOR
RUBBER INSULATION.

THE STANDARD FOR RUBBER INSULATION.

OKONITE WIRES, OKONITE TAPE, MANSON TAPE, CANDEE WEATHERPROOF WIRES
CANDEE, PAT'D. POTHEADS

WILLARD L. CANDEE, H. DURANT CHEEVER } MANAGERS.
THE OKONITE CO., LTD., Sole Manufacturers,
253 BROADWAY, NEW YORK.
GEORGE T. MANSON Gen. Supt.
W. H. HODGINS, Secretary

For 20 Years the Standard

INSULATED WIRES TRADE MARK "O.K." AND CABLES

"O. K." Weatherproof Wire
"Parac" Rubber Wire
Bare Copper Wire
Slow-Burning Weatherproof
Railway Feeder Wire
Slow-Burning Wire

PHILLIPS INSULATED WIRE COMPANY
PAWTUCKET, R. I.

THE PHOENIX GLASS CO.,
PITTSBURG NEW YORK CHICAGO
MANUFACTURERS OF
ELECTRIC GLOBES AND SHADES
Both Arc and Incandescent.
Inner and Outer Globes for all Enclosed Arc Systems.
Catalogues sent on request.

THE ROEBLING
STANDARD
WHITE CORE
RUBBER COVERED WIRE

[illegible] Fremont Street, [illegible] FRANCISCO.
117 Liberty Street, NEW YORK.
173 Lake Street, CHICAGO, ILL.

WORKS: TRENTON, N. J.

"DIAMOND H"
SWITCHES
TRADE H

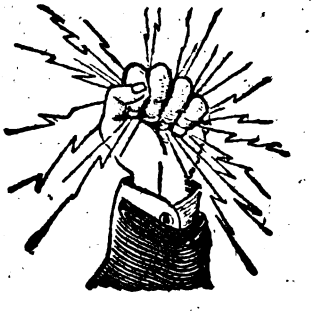
Comply with all Underwriters' Rules.
Write for Circulars and Prices.

THE HART MFG. CO. HARTFORD CONN.

I-T-E CIRCUIT BREAKERS
THE CUTTER CO.
PHILADELPHIA

American Electrical Works,
PROVIDENCE, R. I.

Electric Light Line Wire,
Incandescent and Flexible Cords,
Railway Feeder and
Trolley Wire.



BARE AND INSULATED
ELECTRIC WIRE.

Galvanized Telephone and
Telegraph Wire, Steel Guy Wires
and Flexible Strands.

COPYRIGHT 1908, BY H. C. BOWEN, JR.

CENTRAL STATION BUYER'S DIRECTORY, PAGE 37

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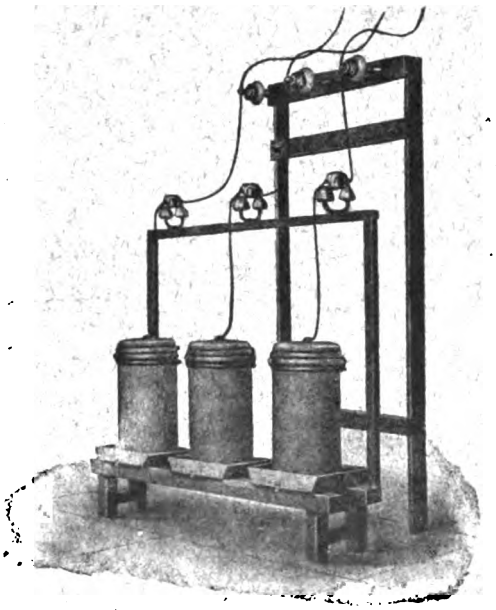
Westinghouse

Electrolytic Arresters

As developed by this Company, is now recognized as the coming type of arrester for most applications. Watch competitors follow our lead.

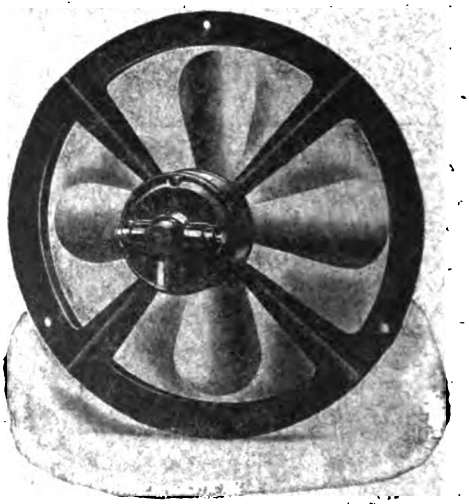


Electrolytic Lightning Arresters.

Circular No. 1146 contains a fully illustrated description of Electrolytic Lightning Arresters. Ask our nearest office for a copy.

Electric Fans

Westinghouse Electric Fans represent the successful culmination of a series of experiments, carried through many years, to determine the exact blade curvature required to produce the greatest breeze with the least consumption of power.



Westinghouse Fans are made with 8, 12 and 16-inch blades in the Combination Desk and Bracket and Ventilating types, and 57-inch blades for Ceiling, Floor and Counter-column types.

Full particulars in our 1908 Art Catalogues.

Westinghouse Electric & Mfg. Co.

Atlanta Buffalo Cleveland Detroit New Orleans Pittsburg San Francisco
Baltimore Chicago Dallas Kansas City New York St. Louis Seattle
Boston Cincinnati Denver Los Angeles Minneapolis Philadelphia Salt Lake City Syracuse
Canada: Canadian Westinghouse Co., Ltd., Hamilton, Ont. Mexico: G. & O. Braniff & Co., City of Mexico

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ELBLIGHT

LAMPS AND CABLES

MAKE ELECTRICAL DECORATING EASY

Conventions and Celebrations SOLD OR RENTED AT ATTRACTIVE RATES Department Stores

NO SHOP WORK. NO ADVANCE PREPARATION. EASY TO INSTALL. EASY TO REMOVE.
BETTER EFFECTS. LESS EXPENSE.

WRITE FOR OUR FREE DELIVERY RENTAL SERVICE PROPOSITION

ELBLIGHT COMPANY OF AMERICA, 36 EAST TWENTY-THIRD STREET, NEW YORK

NEW WESTON ALTERNATING CURRENT PORTABLE and SWITCHBOARD AMMETERS ANB VOLTMETERS

ARE

Absolutely Dead Beat. Extremely Sensitive.

Practically free from Temperature Error.

Their **indications are practically independent of frequency** and also of **Wave form.**

NEW WESTON ECLIPSE DIRECT CURRENT SWITCHBOARD AMMETERS and VOLTMETERS

(Soft Iron or Electro-magnetic type) are

Remarkably accurate. **Very low** in price.

Admirably adapted for general use in small plants. Well made and nicely finished.

All of these NEW INSTRUMENTS are excellent in quality but low in price.

Correspondence regarding these and our well-known standard Instruments is solicited by

NEW YORK OFFICE: 74 Cortlandt St.

Weston Electrical Instrument Co.

NEWARK, N. J.

SWITCHBOARDS

AC OR DC

FOR HIGH OR LOW VOLTAGE

IN STANDARD OR SPECIAL PANELS

FRANK ADAM ELECTRIC CO.

ST. LOUIS

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The best advertisement of any company that makes really good apparatus is the quality of its product. Printed announcements serve merely to introduce the manufacturer to the possible purchaser. That is the purpose of this advertisement. We want to become acquainted with the readers of THE CENTRAL STATION. We want them to become acquainted with us—so well acquainted that when in the market for any kind of a motor starting or speed regulating device they will think, first of all, of **The Cutler-Hammer Mfg. Co., Milwaukee.**

Self-Starter for A. C. Motor

Our business, now the largest of its kind in the world, was a little business sixteen years ago. We didn't advertise then, but we made good apparatus (good measured by the standards of that day) and the apparatus made friends for us. Many of these early patrons are still our customers to-day.

The business grew. New buildings were erected. Our output was doubled—trebled—quadrupled. Then more buildings—more machinery—more operatives, and all the while—more friends!

Advertising didn't make this business the largest of its kind in the world—it was the quality of the apparatus turned out of the shop that did that. Advertising, alone, has never added the name of a single customer to our books. But advertising has brought us thousands of letters of inquiry from people who otherwise might never have heard of us, nor we of them.

The letters we receive come from all parts of the country and from people engaged in many and various lines of work—managers of central stations, consulting engineers and architects, electrical supply houses and contractors, college professors, manufacturers of motors, machine tools, pumps, air compressors, ventilating fans, cranes, elevators, etc.; foremen of machine shops and printing offices, mill and mine superintendents, railroad men, inside wiremen, electricians of industrial plants, etc.

Machine Tool Controller

The only thing that counts in the long run is the quality of the product.

A. C. Motor Starter

These inquiries received the most careful attention. They are the seeds from which orders grow. Every morning the Chief Engineer and his assistants assemble in the office of the General Manager and the mail is read aloud. Your inquiry (if you favor us with one) will be answered by one of this group, but that answer will represent—not the opinion of one man—but the consensus of opinion of a group of engineers who have been described as "the court of last resort on the subject of electric control."

From the very start—sixteen years ago—The Cutler-Hammer Mfg. Co. has specialized along one line—the control of electric motors. Cutler-Hammer apparatus (counting standard constructions only and taking no account of the large number of special devices built to meet exceptional conditions) comprises to-day more than 2,500 types and sizes of electric controlling devices. These standard constructions are all pictured and described in our general catalog which is sent free on request to those who really have occasion to use it.

Speed Regulator

We **know** that we can be helpful to anyone who uses electric motors and who wishes to control them either by manually operated starting and speed regulating devices, installed in the vicinity of the motor, or by solenoid operated devices designed for automatic operation or remote control. The **Index of Bulletins** printed below will give you an idea of the scope of our work.

Elevator Controller

Write us to-day, if you have before you any problem involving the starting, stopping or speed control of electric motors and we will send you illustrations, prices and full description of apparatus that will accomplish the desired result.

The Cutler-Hammer Manufacturing Co.

MILWAUKEE, WISCONSIN

New York Office: Hudson Terminal (50 Church St.)
Pittsburg Office: Farmers' Bank Building
Chicago Office: Monadnock Block
Boston Office: 176 Federal Street

INDEX TO CUTLER-HAMMER BULLETINS

Alternating Current Apparatus
Starting Rheostats, Bulletin 18. *Self Starters,* Bulletins 33, 34 and 35. *Elevator Controllers,* Bulletins 56 and 57.

Crane Controllers
Radial Arm, Bulletin 59. *Drum Type,* Bulletins 66 and 66A. *Rope Operated,* Bulletins 59 and 69.

Dimmers
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Fl at Switches
Bulletins 71 and 73.

Machine Tool Controllers
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Organ Regulators
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Pressure Regulators
Bulletin 71.

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Resistances
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Self Starters
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Solenoid Switches
Bulletin 74.

Speed Regulators
Bulletins 24, 25, 40, 41, 42, 43, 44, 44½, 45, 49, 59, 61½, 62, 64, 65, 66, 66A, 67, 67½, 68, 68½, 69, 75, 76, 77, 78, 79 and 81 to 89½ inclusive.

Starting Rheostats
Alternating Current, Bulletin 18. *Direct Current,* Bulletins 10, 10½, 12, 13, 16, 17, 20, 21, 24 and 25.

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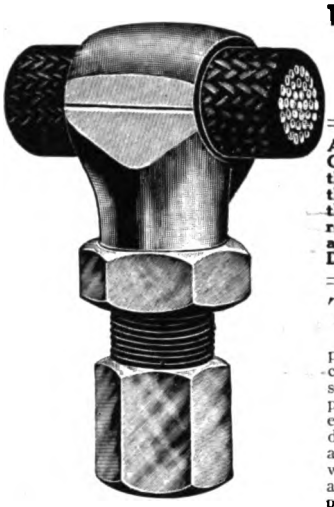
DOSSERT JOINTS



CABLE TAP

The Only Officially Approved Solderless Connector

A MARVEL OF CONVENIENCE AND EFFICIENCY

Adopted by the United States Government and specified throughout for the wiring of the magnificent new annex to the Senate and House of Representatives and for extensions and renewals in various Department Buildings.

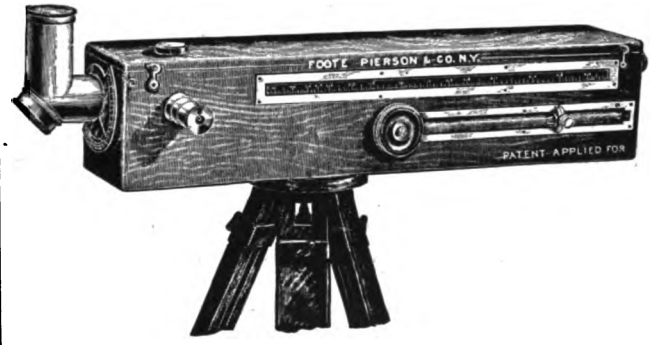
THE Dossert Solderless Wire and Cable Connector is the most important advance made in recent years in electrical construction and is rapidly displacing the old, troublesome, expensive and inefficient soldering process. It can be applied by any ordinary workman in a few minutes and furnishes an absolutely perfect mechanical and electrical connection.

Write for the Most Suggestive and Valuable Bulletin in the Trade

DOSSERT & COMPANY

242 West 41st Street NEW YORK

The Sharp-Millar NEW Portable-Universal Photometer



Measures the candle-power of *arc* and *incandescent lamps* and *gas lights*. *Measures illumination intensity* of surface at any angle. An instrument of precision and accuracy. Simple, portable, small and compact. A valuable laboratory asset.

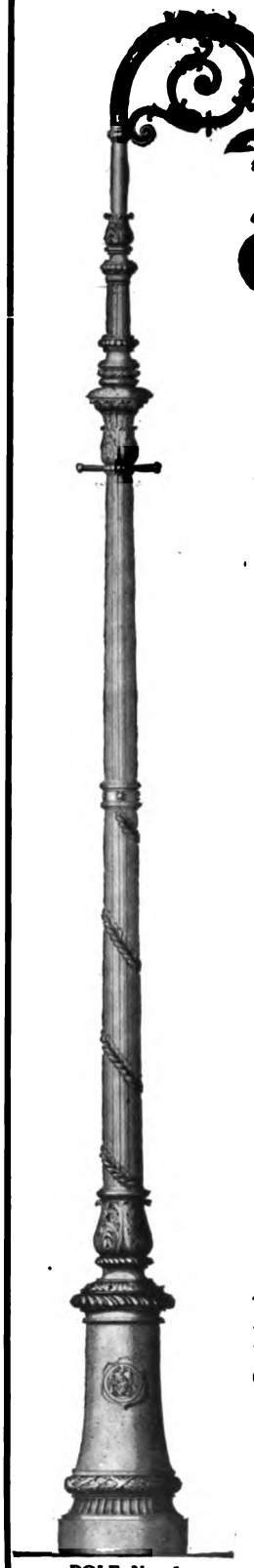
Full description in Bulletin now ready.

FOOTE, PIERSON & CO.

Manufacturers and Sole Licensees

160-162 Duane Street, New York

ARC LIGHT POLES



POLE No. 1

ORNAMENTAL LAMP POSTS AND BRACKETS

We make a specialty of high class Arc Light Poles, Posts, Electroliers and Brackets for

Street Lighting

Public Buildings

Hotels and Apartment Houses

Central Stations who have used our Poles for years claim they

COST LESS

than so-called cheap Poles where durability is concerned.

Designs and Estimates on Application

THE J. L. MOTT IRON WORKS

FIFTH AVE. and 17th ST., NEW YORK

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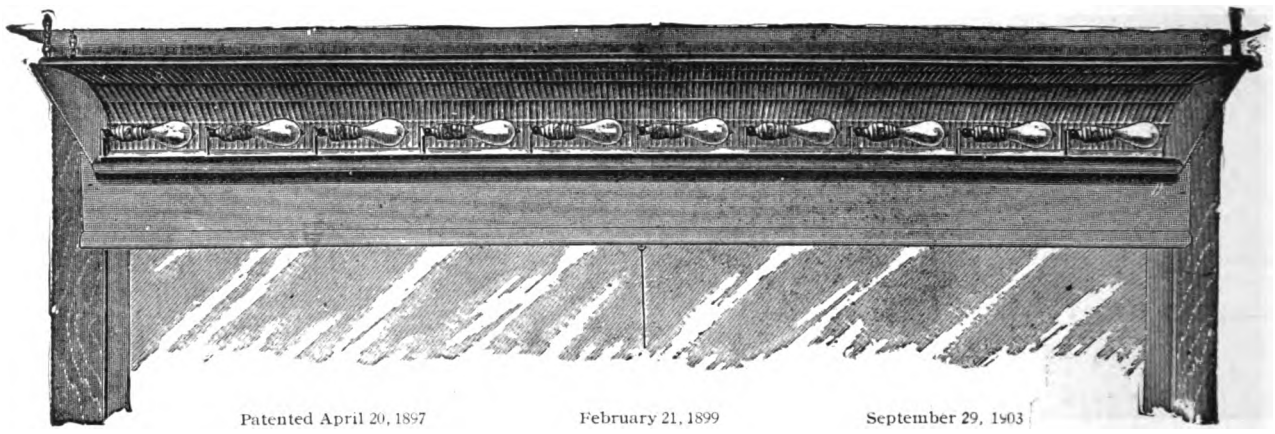
The Only Fixture That Perfectly Meets Every Requirement of Window Lighting



Patented April 20, 1897 February 21, 1899 September 29, 1903

HIGHEST AWARDS EVERYWHERE

FRINK'S SPECIAL PATENT WINDOW REFLECTOR

Any progressive merchant knows that GOOD STOCK NEEDS GOOD LIGHTING. The better the window display, the greater the necessity for perfectly lighting it. Frink's Patent Special Window Reflector is THE perfect fixture. It has been installed in leading stores throughout the United States. Let us send you a careful estimate of your next job of store lighting, not only on window reflectors, but on our unequaled cluster reflectors for lighting the interior, and we will send you a partial list of large mercantile houses to which your customer can refer if he is in doubt about our goods.

REFLECTORS FOR ALL PURPOSES

I. P. FRINK, 551 Pearl Street - - - - NEW YORK

BEGINNING Thursday, February 6th, we increased the facilities of our Art Department by the addition of a night staff. This night staff is adequate in numbers, experience and versatility, to maintain the standard of quality associated with the name of The Ethridge Company in the minds of the advertising public. The advertiser, or the advertising agent who finds himself at the close of business, or during the evening, to be in immediate

NIGHT & DAY

or urgent need of a finished drawing or a series of rough sketches, will now have a place to turn for prompt and satisfactory service, and to secure whatever he may need for inspection in the morning, or for shipment out of town that same night. It should be stated that the establishment of this night staff is not an experiment, but is made necessary by the constantly increasing pressure upon the resources of our Art Department. At a time when business in general is not in a particularly flourishing condition a demand of this nature and extent constitutes an impressive and significant tribute to the character of our work and the results which it produces.

THE ETHRIDGE COMPANY, 41 Union Square, New York

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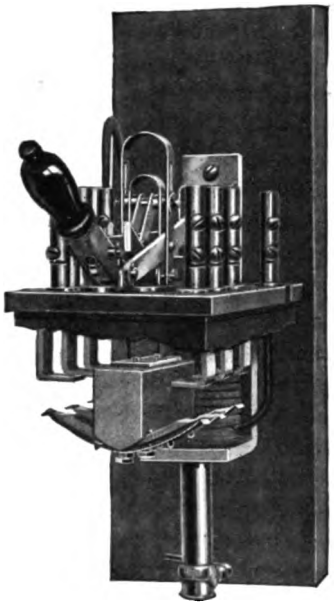
STUART=HOWLAND CO.

Carry in stock and ship promptly everything Central Stations use, from a Generator to a Fuse Plug. Largest stock and best facilities for prompt shipment in the East.

261-287 DEVONSHIRE STREET **BOSTON** 4-5 WINTHROP SQUARE



TYPE L S OIL CIRCUIT BREAKER

For the protection of small motors at voltages of 600 or less, capacities not to exceed 100 amperes.

It is small and compact, strong and durable, and is so arranged that it cannot be held closed on a short circuit.

We can supply any thing you wish in Oil Circuit Breakers or Switches.

Main Office and Factories

CONDIT ELECTRICAL MFG. CO.

BOSTON, MASS., U. S. A.

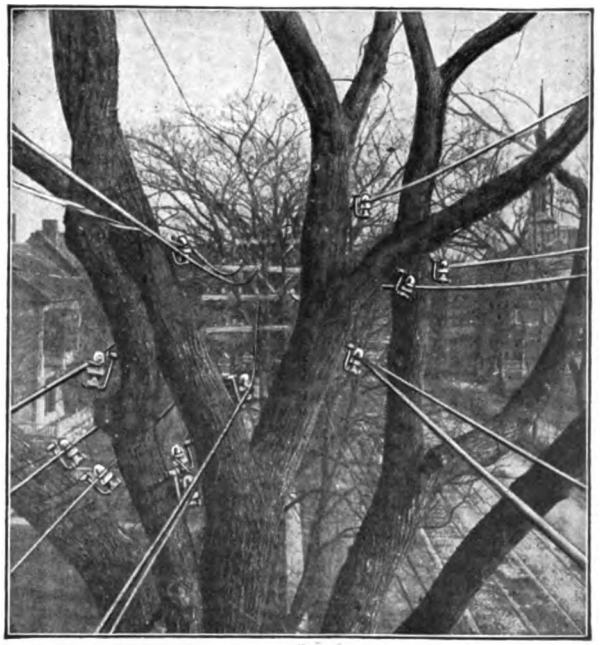
BRANCH OFFICES

E. W. MASON, New York City, N. Y.
THE WEINSHEIMER CO. Chicago, Ill.
THE PHILADELPHIA ELEC. CONST. CO., Philadelphia, Pa.
W. P. ANDOS, Cleveland, Ohio.
LUDWIG, BOMMEL & CO., Pittsburg, Pa.
DEAN, EMERSON & CO., Cincinnati, Ohio.
S. M. KEERLE, St. Louis, Mo.
ROLLINS & COCHRAN, Portland, Ore. (State of Idaho).
W. A. EKBERG, San Francisco, Cal.
C. W. DONGARE, Toronto, Can.
THE NORTHERN ELEC. & MFR. CO., Montreal, Can.

DUNTON Tree Insulators

PATENTED

THE ADOPTED STANDARD



Cut shows insulators installed in Arlington, Mass., by the Edison Electric Illuminating Co., of Boston

Wire ties in solid to glass. Swinging arm allows for motion of tree. Glass screws on standard Locust Pins.

WRITE FOR DESCRIPTIVE CIRCULAR

DUNTON & FIELD, 117 Main St., Cambridge, Mass.

The

ELECTRIC CABLE CO.

Manufacturers of

Voltax, the insulating compound. Voltax wires and cables. Weather-proof wire. Magnet wire. Field and armature coils.

17 Battery Place, New York
925 Old South Building, Boston
324 Dearborn Street, Chicago

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SHAWMUT

FUSES AND CUTOUTS

FOR EVERY KIND OF

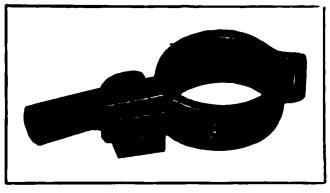
CENTRAL STATION SERVICE

All Fuses Carefully Tested and Inspected

Send for Catalogue

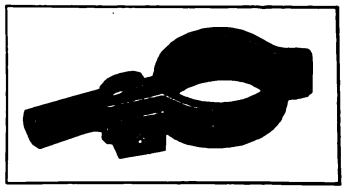
SHAWMUT

GROUND CONNECTION CLAMPS



TWO-PIECE

CONSTRUCTION



Made in Sizes from ½ inch to 3 inches

Solder Lug Part of One Half of Clamp

Most Satisfactory Clamp
On the Market To-day

CHASE-SHAWMUT CO.

NEWBURYPORT <S> MASSACHUSETTS

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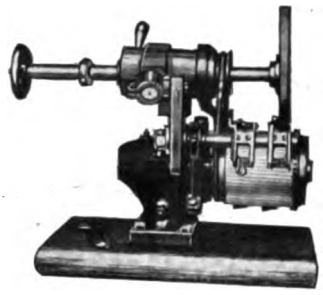
EVERY ELECTRIC LIGHT PLANT SHOULD HAVE IT



A Jordan Commutator Truing Device

¶ This Device will true your commutator without removing the armature, easy to attach and operate. ¶ Does not take large cuts which shortens the life of a commutator, no dragging of copper across the insulation between the bars thereby short circuiting the same, and will soon pay for itself. We can give you a long list of satisfied users.

Patented April 16th, 1898. Patented May 16th, 1905.

Manufactured by

JORDAN BROS., Inc., 74 Beekman St., N. Y. City

SILVER MEDAL AWARDED AT JAMESTOWN EXPOSITION, 1907
HIGHEST AWARD IN ITS CLASS

CUSTOMER'S TEST

Your house customer judges electric heating in general by the behaviour of the particular utensil you let her try. It is that first test that counts. Failure breeds a prejudice that it takes much to overcome. Success makes a "day load" customer who will use more and more current as she finds new advantages in electric heating and cooking.

For years Simplex Electric Household Irons have stood that "customer's test" with such special success, that today Simplex Quality is recognized as the standard of the market.

In our exhibit at the N. E. L. A. Convention, you will find a complete display of Electric Irons, Cooking appliances and Electric heating conveniences for the house customer, that we trust you will examine.

SIMPLEX ELECTRIC HEATING CO

CAMBRIDGE, MASS.

MONADNOCK BLOCK, CHICAGO

"SEEN EVERYWHERE"

EXCELLO
Flaming Arc

FOR OUTDOOR OR INDOOR SUN RAY OR PEARL WHITE

The most powerful artificial illumination.

3000 c. p., 550 watts, 17 hours life.

Excello Arc Lamp Co.

30 East 20th St. NEW YORK

CHICAGO BRANCH 118-132 West Jackson Boulevard

ADVERTISERS

in

THE CENTRAL STATION

do not have to pay for a circulation among Telephone, Telegraph and other readers who have no use for their product.

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The Hartford Time Switch

Approved by
Fire Underwriters' Inspectors

Furnished 10 to 50 amp. Single and Double Pole and 10 to 85 amp., Single, Double and Triple Pole.

Throws current **ON** or **OFF**, and gives light when needed without waste. Is weather-proof.

A weekly winding the only attention required.

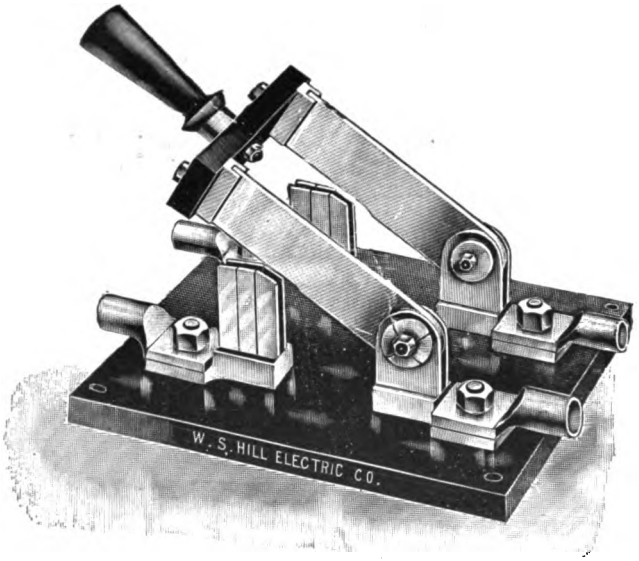
Type B, on and off daily. Type C, on and off daily; omits Sunday. Type D, on and off twice daily.
For prices and details, ask for catalog.

HARTFORD TIME SWITCH CO.

97-99 Warren St. **New York**

Hill Switches

THE STANDARD



STYLE B, 250 VOLT

W. S. Hill Electric Company

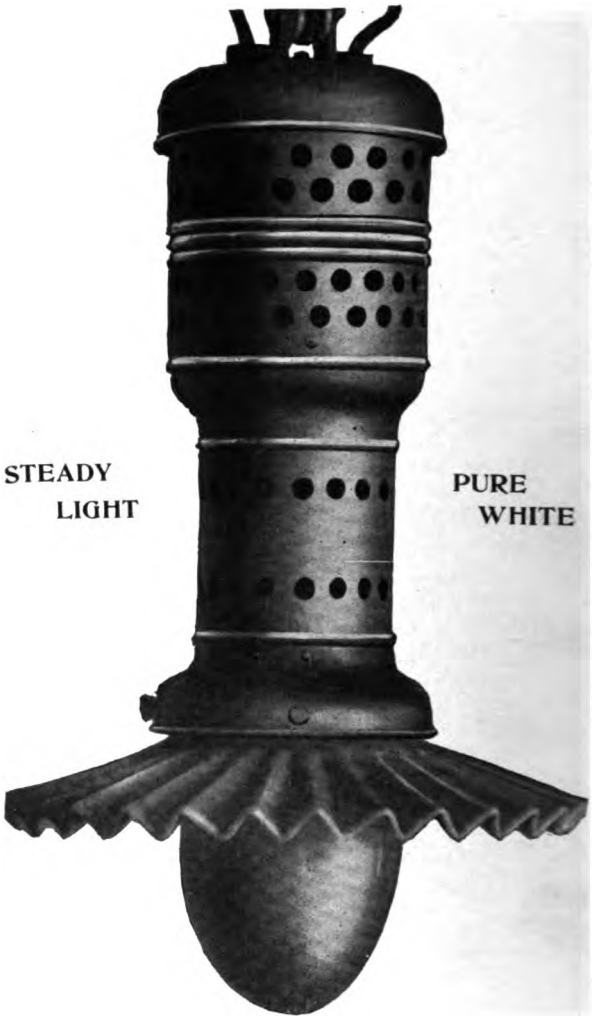
NEW BEDFORD, MASS.

THE NEW MINIATURE

Queen Acme Arc

LATEST AND BEST

For Direct or Alternating Light or Power Circuits.



Current Consumption of only 5 Incandescent Lamps. Light of 50. 1,000 C. P. at 2.75 Amperes. Trim Life 28 to 30 hours.

Especially Adapted to Offices, Stores, Factories and Public Buildings.

The Efficiency of This Lamp Will Make MORE CENTRAL STATION CUSTOMERS.

WRITE US

QUEEN & CO., INC.

PHILADELPHIA

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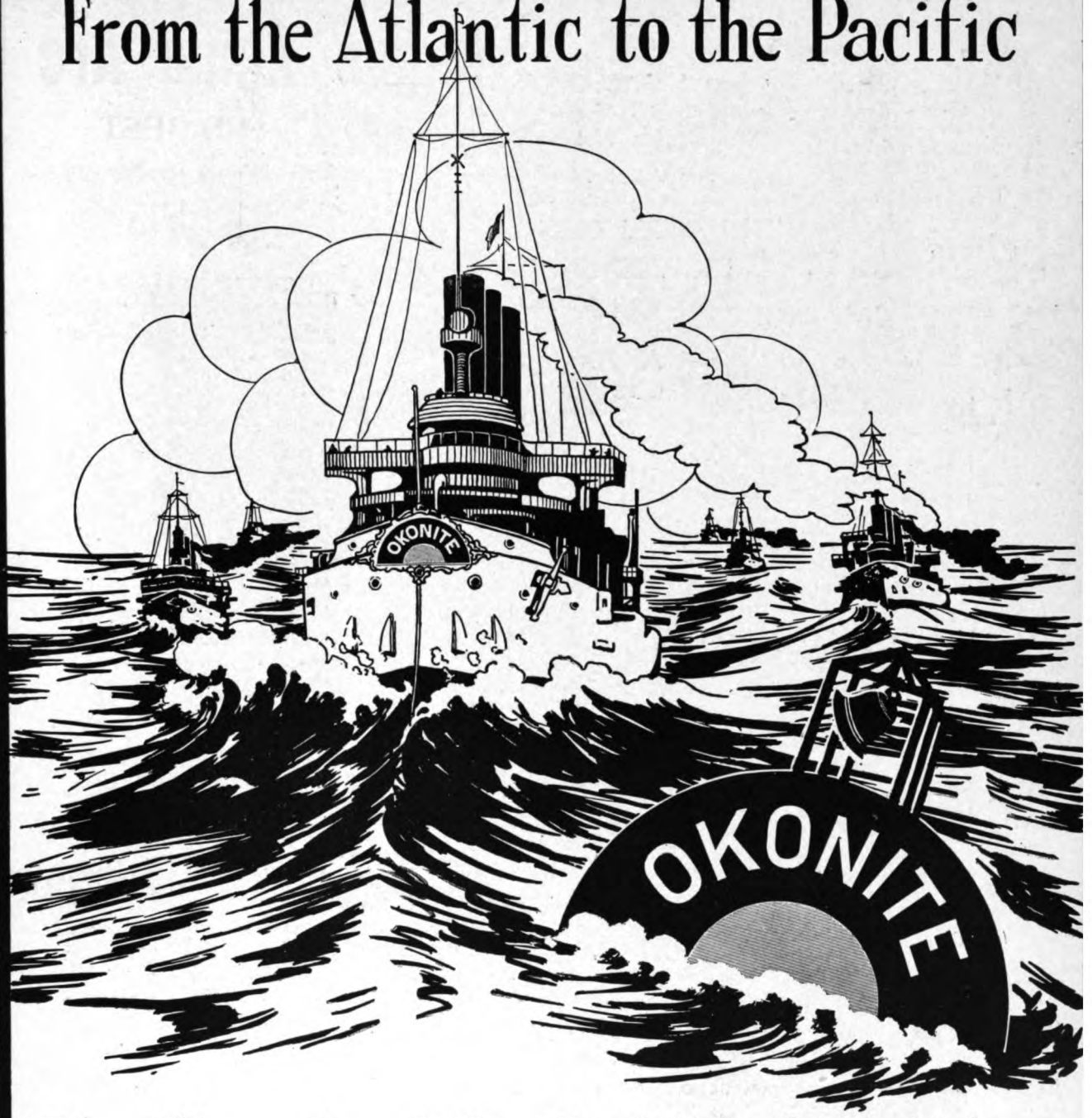
From the Atlantic to the Pacific



The Standard for Rubber Insulation

OKONITE keeps you in the channel of success
No grounding No breakdowns

THE OKONITE COMPANY Ltd.
253 BROADWAY NEW YORK

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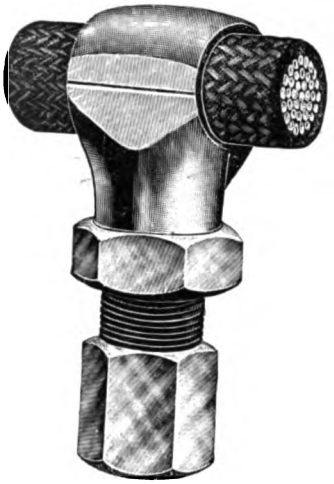
DOSSERT JOINTS



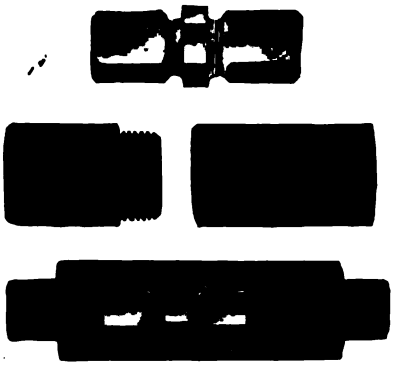
CABLE TAP

These connectors will be furnished to tap from any size Main to any size Branch. No cutting of the cable. Save their cost in cable.

2-WAY, TYPE A, SHOWING DETAILS

THE ONLY OFFICIALLY APPROVED SOLDERLESS CONNECTOR

A Marvel of Convenience and Efficiency



DOSSERT INSULATED COVER

These insulated covers are for a special type of connector and are not made for sizes larger than No 1 stranded.

Why Solder?

The Code authorizes the use of

Dossert Joints

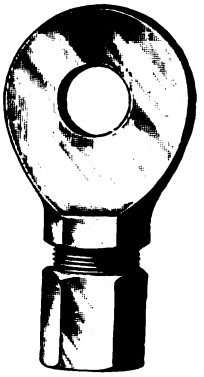
WITHOUT Solder. They are approved and endorsed by leading engineers.

SAVE Cable.	**ARE** Durable.
SAVE Solder.	**ARE** Adjustable to all Size Cables.
SAVE Gasoline.	**ARE** Convenient.
SAVE Time.	**ARE** Adaptable to all conditions.
SAVE Labor.	**ARE** Inexpensive.
SAVE Money.	**ARE** Cheaper in Quantities.
SAVE Trouble.	**ARE** Economical.
SAVE Blow Torches.	**ARE** Safe.

Used in the Four Leviathans of Modern Times

Metropolitan Life Tower
Singer Building
City Investing Building
Hudson Terminals

They make the biggest Joints in the smallest space. Used on the 2,500,000 C. M. feeder cables on the Williamsburg Bridge.



BACK LUG

The Dossert Solderless Wire and Cable Connector is the most important advance made in recent years in electrical construction and is rapidly displacing the old, troublesome, expensive and inefficient soldering process. It can be applied by any ordinary workman in a few minutes and furnishes an absolutely perfect mechanical and electrical connection.

Write for the most suggestive and valuable bulletin in the trade

FRONT LUG

DOSSERT & COMPANY

242 WEST 41st STREET NEW YORK

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THE QUESTION OF THE DAY

WHERE IS THE LIGHT MOST VALUABLE ?

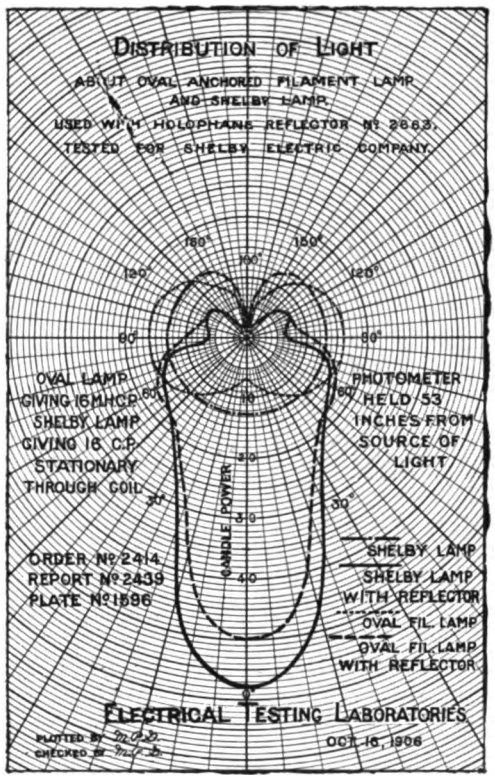
NOTE: Lamps taking same current, giving equal spherical candle power, have the same life

Tungsten Lamps

Tantalum Lamps

Miniature Lamps

We make over 600 Different Types


DISTRIBUTION OF LIGHT
ABOUT OVAL ANCHORED FILAMENT LAMP AND SHELBY LAMP
USED WITH HOLOPHANE REFLECTOR NO. 2663.
TESTED FOR SHELBY ELECTRIC COMPANY.
OVAL LAMP GIVING 16 MHCP
SHELBY LAMP GIVING 16 C.P. STATIONARY THROUGH COIL
PHOTOMETER HELD 53 INCHES FROM SOURCE OF LIGHT
ORDER No. 2414
REPORT No. 2439
PLATE No. 1596
CANDLE POWER
SHELBY LAMP
SHELBY LAMP WITH REFLECTOR
OVAL FIL. LAMP
OVAL FIL. LAMP WITH REFLECTOR
ELECTRICAL TESTING LABORATORIES
OCT. 16, 1906

Useful Light Lamps

Oval Anchored Carbon Lamps

Tipless Lamps

We make over 600 Different Types

The above shows results of test made of Shelby Useful Light Lamps against Oval Filament Lamps. Both lamps had the same spherical candle power, same current consumption, same life, first cost the same. The Shelby Type gives

70 Per Cent. More Useful Light

Everyone concedes that the light below the lamp is the *useful light*. Send us your next order.

THE SHELBY ELECTRIC COMPANY

SHELBY, OHIO, U. S. A.

BRANCHES

Boston	New York		Philadelphia	Chicago
Baltimore	Pittsburg		Cleveland	Cincinnati
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JAEGER TUNGSTEN LAMPS

25 AND 40 CANDLE POWER—70 PER CENT. SAVING

THE CENTRAL STATION LAMP

1889
Jaeger Perfection Drop Seal Standard Lamps

1895
Jaeger Perfection of Metallic Filaments for Miniature Lamps

1898
Jaeger Perfection Push Seal Miniature Lamps

1899
Jaeger Perfection Miniature Lamps that Made Ever-Ready Novelties Famous

1904
Jaeger Metallic Filaments for Standard Lamps 2½ Watt Per Candle Power

1889
Jaeger Perfection Automatic Mercury Pumps Coming into use again for Tungsten Lamps

In the State of Perfection

Reduced liability of breakage is only one of the many good features. May we tell you of the others?

1907
Jaeger New Improved Method for Evacuation

1903
Jaeger Perfection Tipless Lamp

TIPLESS LAMP COMPANY

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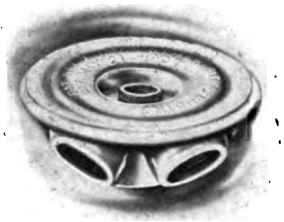
HARTER CLUSTERS

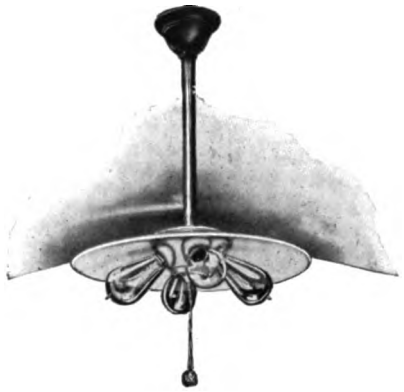
Are OPAL GLASS cast on COPPER CONTACTS



Top View of
CLUSTER
Showing Attaching Nipple
Threaded Inside and Outside

They are a solid body not affected by atmospheric conditions. Can be used ANYWHERE — INSIDE OR OUTSIDE.

No contacts to jar loose.
Simplest and easiest to install.
Can be wired with Number 14 wire.
Always clean and new.
One third brighter than any other cluster.
The entire surface reflects perfectly every particle of light.

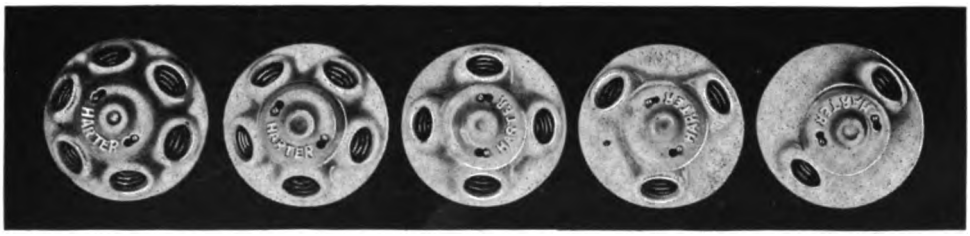


CLUSTER
with Pendant Switch

HARTER SHADE HOLDER

WRITE FOR CATALOGUE AND DISCOUNTS

CLUSTER
and Shade Combination



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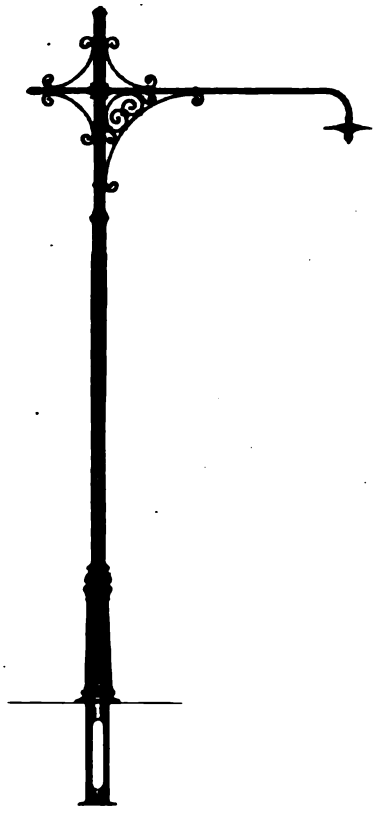

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IRON POLES AND BRACKETS

MADE TO LAST

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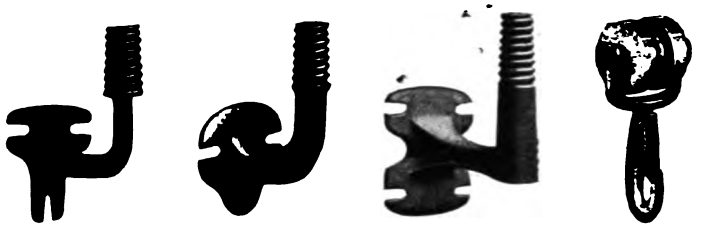

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SPECIAL FORGINGS AND WROUGHT IRON WORK
RAILWAY BRACKETS, CROSS ARMS and TRIMMINGS

We manufacture this material. Our prices are right. Write

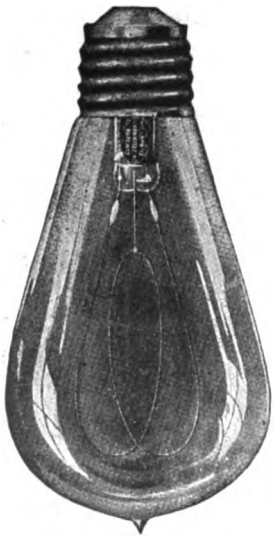
ELMER P. MORRIS COMPANY

72 TRINITY PLACE, NEW YORK CITY

Central Station Managers

WILL FIND IT GREATLY TO THEIR INTEREST TO WRITE TO US FOR SAMPLES AND PRICES ON "WRIGHT" LAMPS

Our lamps *ARE NOT ETCHED "RENEWED"*, neither do we hold you to a schedule of *RE-SALE PRICES*, both of which conditions are required of Association renew factories.



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WE make 4 to 32 C. P., 100-130 volt lamps and also 16 C. P., 200-240 volt lamps.

WE have a nice line of Central Station customers. *WE WANT YOU.*

WE will buy your burnt out lamps for cash or accept them as part payment.

Hill-Wright Electric Co. 105-107 READE ST. NEW YORK CITY

Central Station Managers are particularly invited to write us regarding artificial lamp coloring. Quality excellent—prices very reasonable.

We Have an Interesting Proposition for Agents. This Means You WRITE FOR IT TO-DAY

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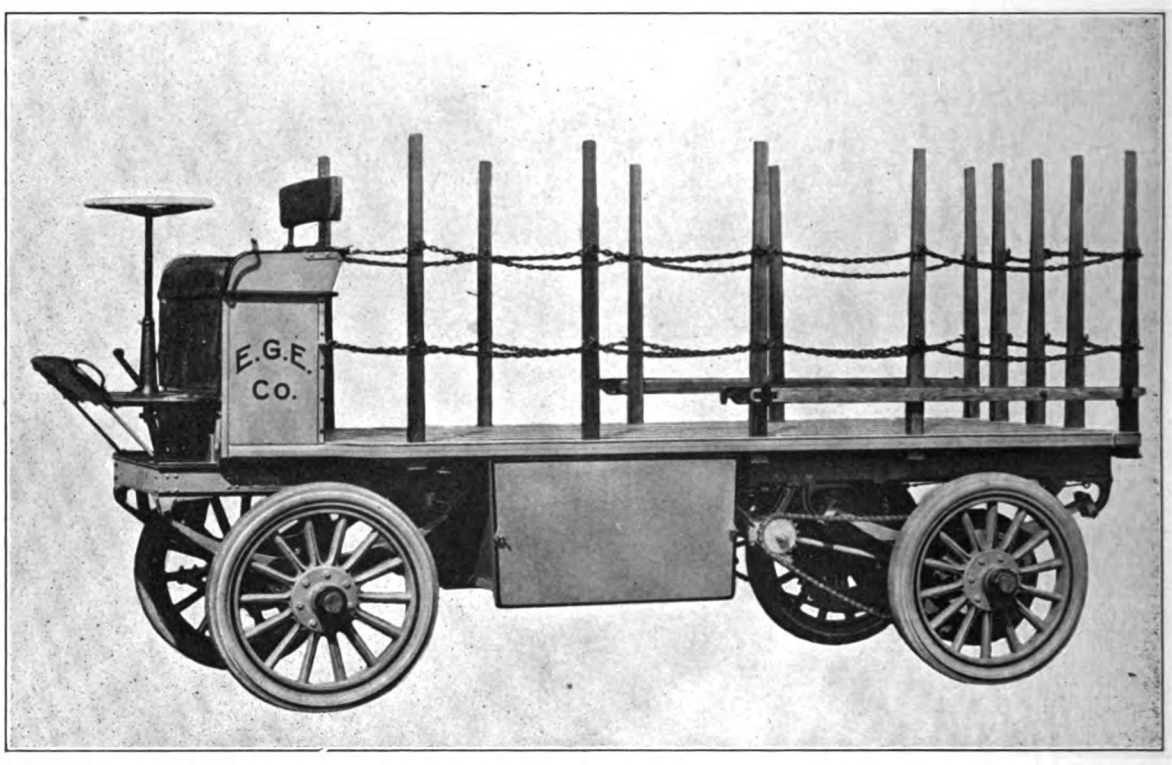

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WHY DON'T YOU INSTALL A

White Star Continuous Oiling System

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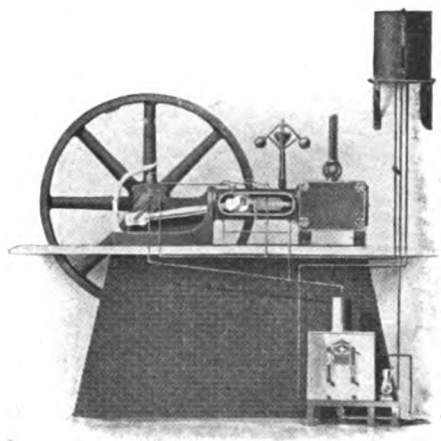
YOU positively cannot afford to keep on in the old rut. The longer you delay, the more money you waste—the more trouble and work you have. ¶ With the **White Star System,** the oil is fed continuously in a steady stream onto all the bearings, passes to the **White Star Filter** for thorough purification by removal of all foreign matter, and is pumped back to the oil reservoir for use again. Thus the oil is worked over and over until actually worn out. ¶ You feed the oil in a copious flood, yet without waste. **Not a drop is lost.** ¶ The advantages of this modern mechanical method in engine lubrication are fully exploited in booklet **"P-2"** which we have just issued for distribution to all who are interested.



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GROUND CONNECTING CLAMP
For Grounding Metal Conduit and Lead Cables
Patent Pending

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TAKES GROUND WIRE To No. 4, B. & S.

NATIONAL ELECTRICAL CODE STANDARD
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Ask for Prices and Discounts . . .

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"*The* Only Turn Down Lamp *on the* Market"

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PULL STRING
8—½ C. P.
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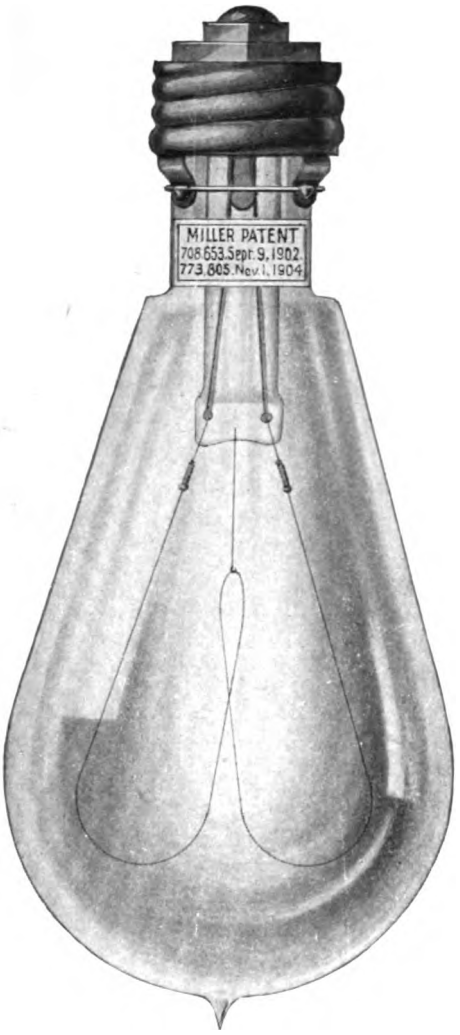
37,000 Miller Incandescent Lamps



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Having taken over the entire stock of *Miller Lamps*, manufactured by The Missouri American Electric Co. at a favorable price, we are prepared to furnish our customers with this excellent lamp at

12 Cents (4-16 c.p. 100-130 volts)
Former price 18 cents

15 Cents (32 c.p. 100-130 volts)
Former price 27 cents

14 Cents (8-16 c.p. 200-250 volts)
Former price 20 cents

The above prices in lots of 1000 or more

These lamps are brand new and are packed in their original cases direct from the shipping department of the factory—every lamp guaranteed perfect.

HOW MANY THOUSANDS
CAN I SHIP YOU?

Write me personally to-day before they are all gone

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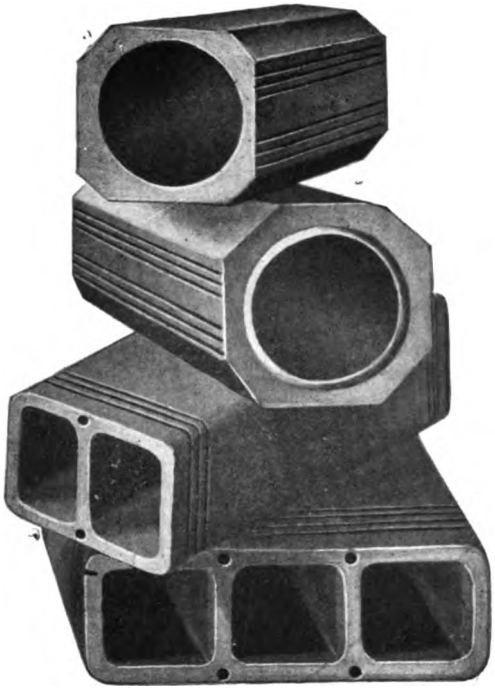
Our Factories are the Largest in the World. Annual Capacity 40,000,000 feet of Conduit



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3½ inch Round Bore
3½ " " "
4 " " "
3½ " Square "
3½ " Round "
(Socket Joint)

MULTIPLE DUCT

2, 3, 4, 6 and 9 Duct
3½ inch Square Bore
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Write to Electrical Commission, Baltimore, Md., for their opinion on about 16,000,000 duct feet supplied by us in 10 years.

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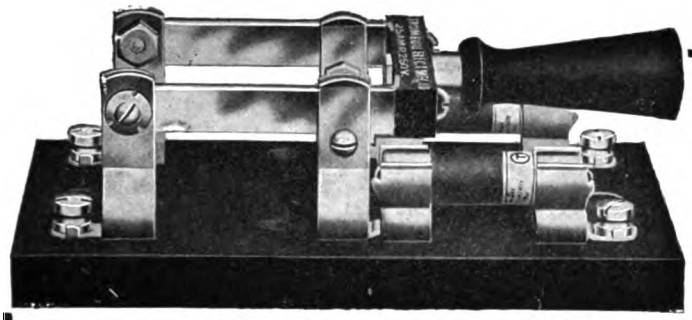

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25-100 AMP.

are approved. The blades are ground in.
Each switch is inspected.

For cabinet work **High Fingers** are used

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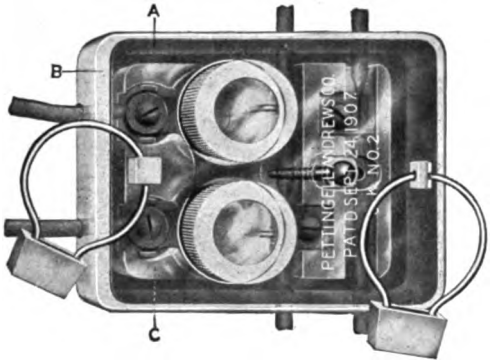
PREVENTS THEFT OF CURRENT



A—Reversible Face Plate
B—Porcelain Canopy
C—Standard Fuse Block

It consists of a porcelain canopy and a steel plate that may be attached to any standard branch block so as to render the live parts of the block inaccessible to unauthorized persons under all conditions of service. The ease with which illegal connections can be made on unprotected fuse block terminals is a temptation worth removing.

Let us tell you how little it will cost to equip your system with this device.

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Central Stations can get a profitable load wherever hot glue is required by installing GE electrically heated glue pots.

The GE Glue Pot has unique advantages over others:

A single, simple aluminum casting takes the place of the cumbersome and troublesome water jacket pot and separate glue pot formerly used.

The old reliable indestructible cartridge heating unit.

Convenient detachable connections.

Most efficient use of current.

70 to 250 watts for 1 qt. to 8 qt. pots.

Keeps clean and wastes no glue. Self regulating.

Completely self-contained and portable.

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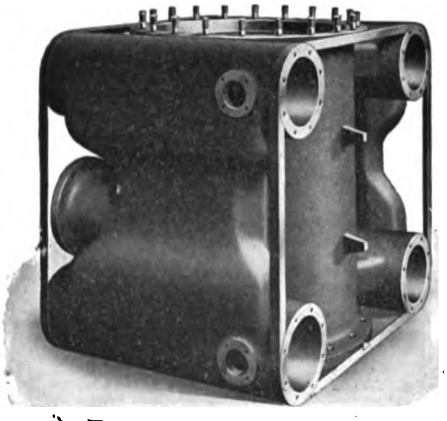
COMPLETE SET BUILT IN THE SAME SHOP.

Economy and Continuous Operation with little Attention.



Compound Engine Medium Speed Forced Lubrication Small Clearances, No Vibration.

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Simplex Electric Heating Co., Cambridge, Mass.

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Queen & Co., Philadelphia.
Foote, Pierson & Co., New York.
Weston Electrical Instrument Co., Newark, N. J.

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Brookfield Glass Co., New York.
Elmer P. Morris Co., New York.

INSULATORS, Tree.
Dunton & Field, Cambridge, Mass.

LAMPS, Arc.
General Electric Co., Schenectady, N. Y.
Queen & Co., Philadelphia.
Excello Arc Lamp Co., New York.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

LAMPS, Incandescent.
Buckeye Electric Co., Cleveland, O.
General Electric Co., Harrison, N. J.
Shelby Electric Co., Shelby, O.
Westinghouse Lamp Co., New York.

LAMPS, Incandescent, Turn Down.
Economical Electric Lamp Co., New York.

LAMPS, Renewed Incandescent.
Hill-Wright Electric Co., New York.

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General Electric Co., Schenectady, N. Y.
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Foote, Pierson & Co., New York.

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Photograph by The New York Edison Company, 55 Duane Street.

Night at Madison Square during the New York Electrical Show, September 30 to October 9, 1907.

THOUGH a remarkable night photograph, it but inadequately pictures the beauty of the illumination at the Madison Square Garden during the Electrical Show of 1907.

Experts have pronounced it one of the most striking and effective examples of modern advertising. It is one of many ways in which

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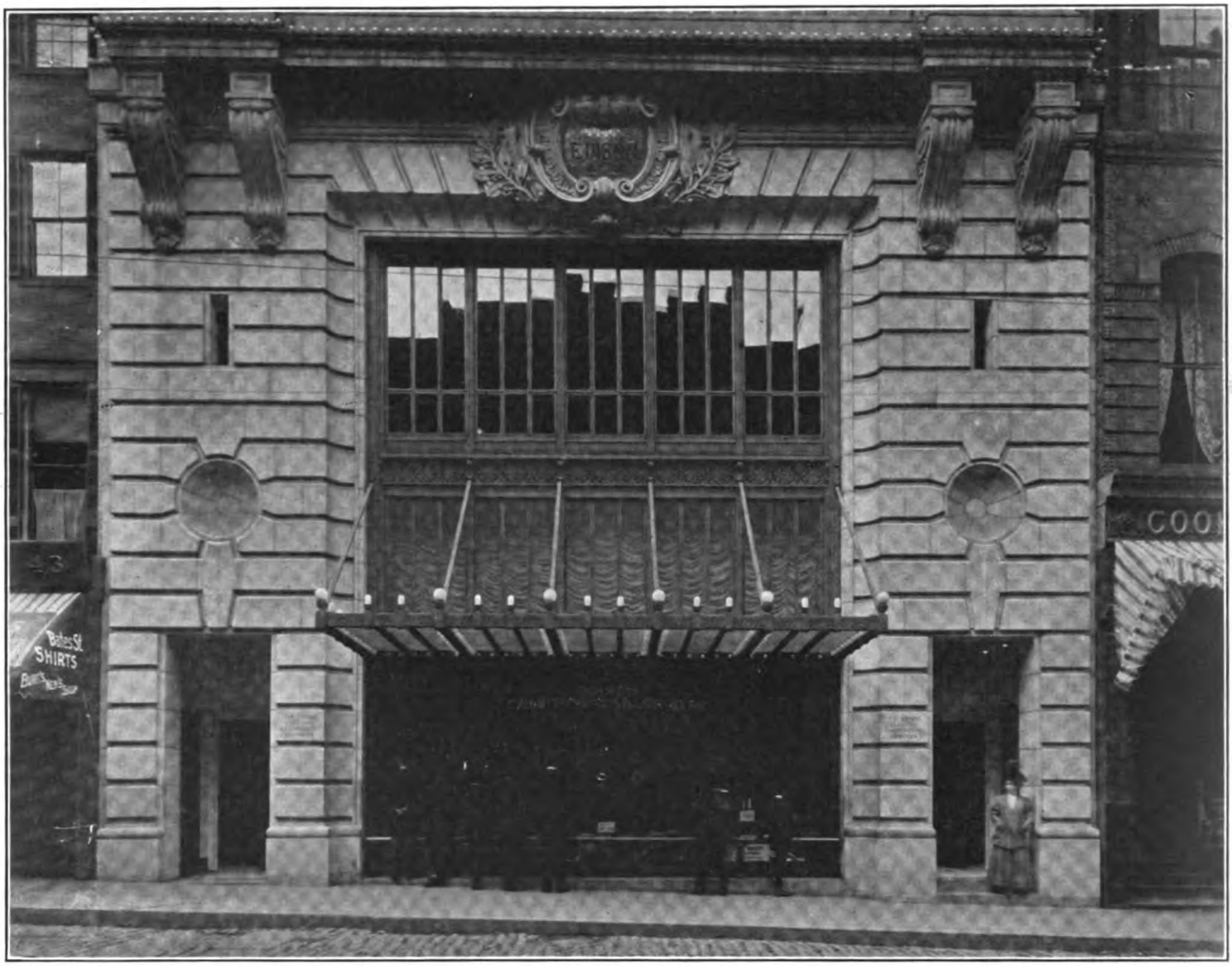

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The first floor of our building is given up to the display and demonstration of Electric lighting, Heating and Cooking devices, together with every other sort of novelty available for use on electric service. Every imaginable device for labor saving and small manufacturing may be seen there. The room is brilliantly lighted throughout the day, and decorative lamps and special lighting are provided for every hour of the night—every night in the year.

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Since the first day the Boston Edison Company opened its Exhibition Department in 1899 the demand for apparatus has been constant, and the company this year undertook the direct sale of goods.

Edison Electric Illuminating Co., of Boston

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For Sale at a Very Low Price

BY THE

Edison Electric Illuminating Company of Brooklyn

On the 30th day of April, 1907, the Board of Aldermen of the City of New York passed "An Ordinance regulating the placing of Electric Signs in the City of New York and providing that the same shall be licensed."

Section 2 of this ordinance reads as follows:

"Electric signs may be hung or attached at right angles to buildings, and extend not to exceed six feet therefrom in said space, and to be ten feet in the clear above the level of the sidewalk in front of such building, upon the payment of an annual license fee of 10 cents for each square foot of sign space or part of square foot of such sign space, to be collected by the City Clerk of the City of New York."

One result of this ordinance has been to displace and render useless for Brooklyn purposes, about 300 panel signs. While these signs themselves do not exceed 5 ft. 3 in. in length, they were attached to buildings in such a manner as to infringe upon the provisions of the ordinance and could not be brought within the 6 feet and 10 feet space limits without modifying or destroying their usefulness to the customer. They comprise various types of popular panel signs, including those with scroll work frames, and are for the most part in very good condition. They are now in our storehouse occupying valuable space.

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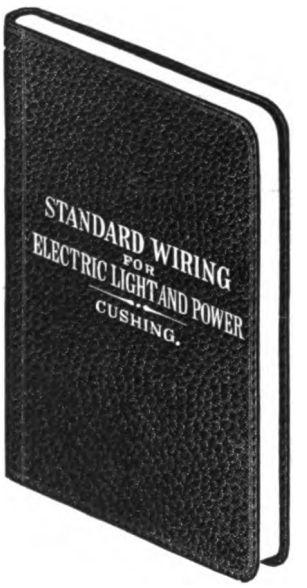

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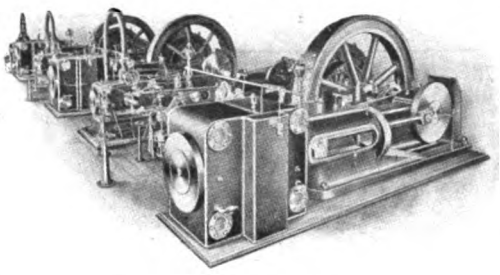

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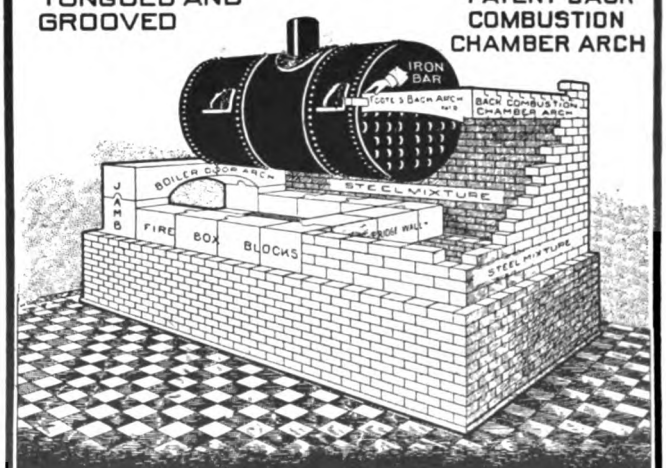

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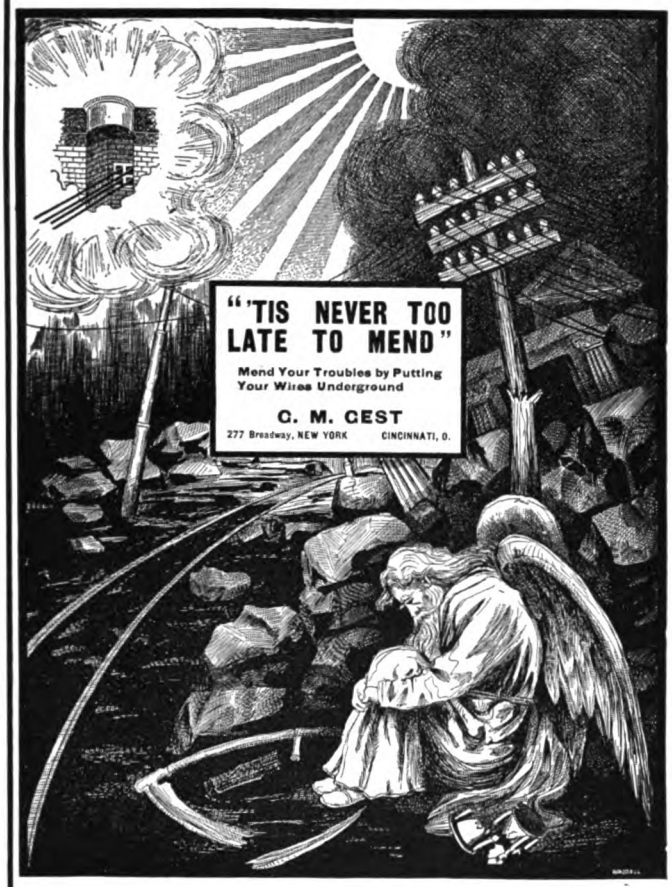
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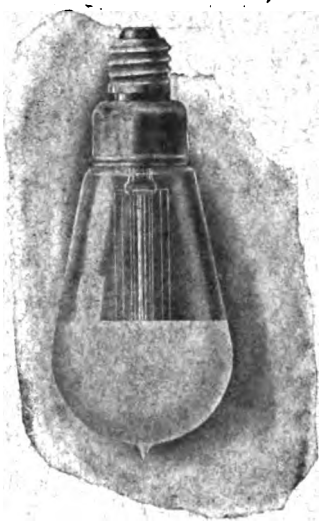

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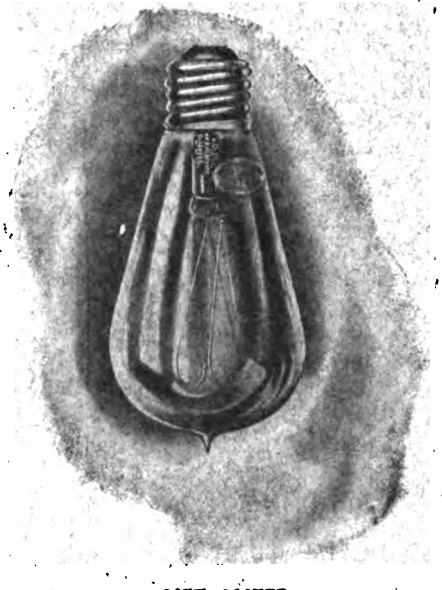

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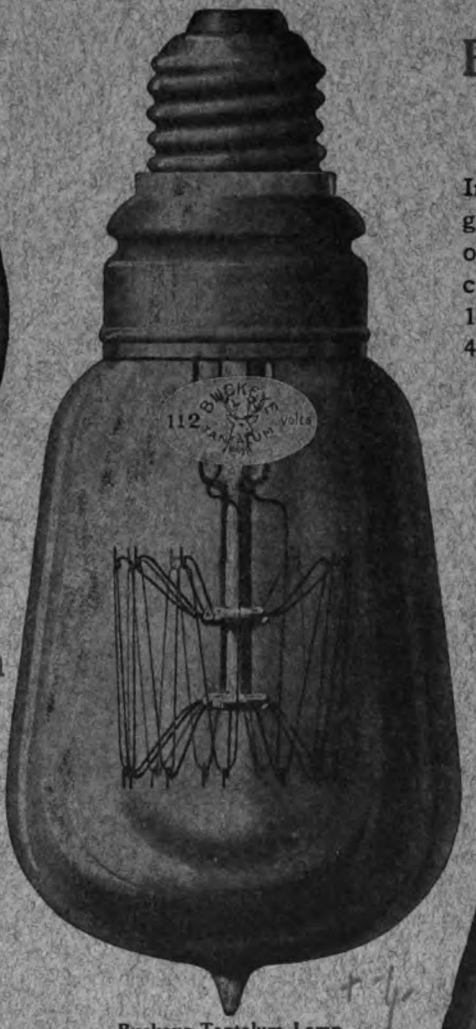

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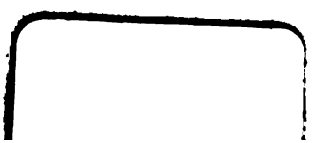

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